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Pr10618 - Specification for Power Systems Analysis and Arc Flash Studies

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1. Purpose

The purpose of this Standard Electrical Specification is to define Unitywater requirements for Power System Analysis (PSA) and Arc Flash Analysis (AFA).

This standard specification defines assessment criteria to determine reliability, safety and PPE requirements for these installations.

This standard specification outlines the general requirements and provides guidelines on how to meet Unitywater requirements on PSA and AFA but is not a site-specific document.

2. Scope

This standard specification applies to Unitywater's fixed electrical assets as specified in the relevant scope of work document.

This specification applies to both complete and partial electrical design and installation works at Unitywater's sites. This includes, but is not limited to, the following:

- Design, supply and installation of all electrical switchboards;
- Design of switchboard workshop drawings;
- Supply and installation of electrical power cabling; and
- Modification to existing plant.

This technical specification forms part of the learning content in uLearn module: 1OARFA – Arc Flash Awareness Course (UW).

3. Planning

3.1. General

During the planning phase the requirements *Pr11079 - Power Systems Analysis Change Management Procedure* shall be followed to determine what changes to the Power Systems Analysis and Arc Flash Assessment report are required.

The site data should be verified at least every five (5) years to confirm if any changes have occurred, especially within the Power Authority network. A Site Data Collection Template (F11199) has been developed and may be used for initial site data collection and for periodic verification purposes.

4. Design

The power system design and/or modifications shall be carried out in conjunction with the electrical design, the Scope of Works, or the Principals Project Requirements or any other overarching document that details the specific requirements for the work.

Any modifications to the Power System design shall be documented within the relevant sections of the Power Systems Analysis and Arc Flash Assessment Report. *F10884 – Report Template – Power Systems Analysis – Network Sites* shows additional sections that indicate change. When the Power Systems Analysis and Arc Flash Assessment report is as constructed the sections relevant to the changes shall be incorporated into the main sections of the report and the 'change' sections shall be retained, however they shall be marked "This report is As Constructed and this section is only relevant during the design phase." The template shall be to populate the required sections of future revisions of the report.

All power system design shall consider the requirements of the following documents:

- Pr9380 - Specification for Electrical Installations at Network Sites (where relevant)
- Pr9835 - Specification for Electrical Installation at Treatment Plants (where relevant)
- Pr10973 - Working Around Switchboards Guide
- Pr9913 - Acoustic Enclosed Generators at Unitywater Sites (Supply and Installation)
- Pr9914 - Solar Power Supply and Installation at Unitywater Sites

5. Construction

During the construction phase any changes to the components/settings etc will be need to be captured for inclusion in the as constructed revision of the PSA Report and PSA Model. Further any changes in the Supply Authority network will also need to be captured.

6. General Requirements

6.1. General

The power system analysis and arc flash analysis studies shall be carried out in conjunction with the Scope of Works or the Principals Project Requirements or any other overarching document that details the specific requirements for the work and must be used to determine which specific component of this standard specification is applicable to each individual site or project.

The native files from the software package must be provided to Unitywater after the final PSA report has been accepted inclusive of all library files and an explanation of the model. Where other Unitywater approved methods for calculation are used, full details of calculations must be provided.

7. Power Systems Analysis

7.1. General

The Power System Analysis (PSA) for the Plant/Site consists of the following sections and appendices within a single report. A template document will be provided for new sites. For sites with an existing PSA the document will be provided for modification.

1. Executive Summary
2. Purpose
3. Scope
4. References
5. Definitions/Abbreviations
6. Overview/Design Basis
7. Operating Scenarios
8. Maximum Demand/Load Flow
9. Power Cable Sizing
10. Fault Study
11. Protection Coordination and Discrimination
12. Arc Flash Study
13. Harmonics Analysis (if applicable)

The following Appendices are also required:

A. Appendix A – Single Line Diagram
B. Appendix B – Maximum Demand/Load Flow Results
C. Appendix C – Cable Sizing Report
D. Appendix D – Fault Study Results
E. Appendix E – Time Current Curves
F. Appendix F – Arc Flash Study Results
G. Appendix G – Generator Data Sheet
H. Appendix H – Harmonic Analysis (if applicable)
I. Appendix I – Labels
J. Appendix J – Site Data Collection

The above relevant sections must be incorporated into a single PSA report with a document number consistent with the numbers assigned for each site. Where sections or appendices are not used they must not be deleted from the report. These sections must be marked as "Not yet assessed". The structure applies to all reports created for Unitywater.

An Electrical RPEQ who is experienced in PSA must review and approve all PSA studies and reports.

Sites that only have a single-phase supply do not need to have a full PSA conducted. Single-phase sites must have an AFA conducted. F10886 - Report Template - Arc Flash Analysis - Single Phase Sites has been developed specifically for single phase sites and consist of the following sections:

1. Executive Summary
2. Single Line Diagrams
3. Labels
4. Site Data Collection

At the completion of construction the PSA Report and PSA Model must be updated to an as constructed state. Any changes made on site must be included in the final report and any changes to the PSA Model must be made. Appendix I – Labels must be updated to include as installed labels. Appendix J – Site Data Collection must be updated with any changes made or discrepancies found on site during construction. This also applies to any protection devices modified.

7.2. Power System Model

The following software packages are acceptable for power system models:

SKM Power Tools for Windows (SKM PTW)The latest version of the nominated engineering software must be used in carrying out any PSA studies.

For single phase sites only, alternate software or calculation methods may be used.

For sites where an existing power system model exists, the same software as the provided model must be used.

The power system model must include transformers, permanent generators, cogeneration units and all distributed loads (MCCs, DBs etc.) The model must be used to calculate the following:

a. Switchboard busbar rating and fault levels at all switchboards.
b. Real, reactive, total apparent power and power factor; and,
c. Transformer and backup generator sizing if not already defined.

The model may be used to determine whether any power factor correction or harmonic filters are required and, where required, separately recommend appropriate sizes for this equipment.

The power system model must be developed with standard naming convention as specified on the model aligned to naming used on drawings and as per Unitywater's asset naming conventions (see *Pr8843 - Specification for Drawing, Document and Equipment Tag Numbering*).

Site data collection is required to ascertain relevant details for accurate modelling and calculation of results. For new sites this data may not be readily available at design stage, however for final handover all site data must be complete and accurate. This site data may be used to verify the model accuracy.

All assumptions are to be explicitly detailed in the relevant section of the report. Power Supply Authority data must not be assumed, a request for data to the relevant Power Supply Authority is required to detail their network accurately in the report.

7.3. Maximum Demand

A maximum demand load calculation based on an electrical load list and actual installed equipment must be provided and must comply with requirements of AS/NZS 3000.

Calculation notes must be included and described adequately.

The diversity factors to be used for load list calculations may be estimated and qualified in the report.

The switchboards internal distribution boards, services distribution boards and other field mounted enclosures may be modelled as combined loads.

The diversity factors to be used for load list calculations are as follows:

- Circuit capacity of each individual load should be based on its full- load rating.
- For switchboards, use driven plant load, OR the following as a minimum:
  - Pumps, Fans: 0.9
  - Lighting: maximum demand
  - Heating Ventilation and Air-Conditioning: 1
  - Uninterruptible Power Supply: maximum demand

Where data exists through Unitywater's electricity retailer or SCADA systems, the existing maximum demand may be adjusted/noted based on the previous 12 months data. This may be used at the discretion of the Engineer as the baseline and maximum loads to allow for further load to be added to the site.

The motor starting currents and power factor are to be based upon data provided as defined in Table 1 and Table 2.

Motor Starting Technology	Motor Starting Factor (LRC/FLA)
Direct online (DOL)	6.0
Direct online with mechanical aid (i.e., fluid coupling, magna drive, etc)	3.0
Variable speed drive (VSD/VVVF)	1.5 to 2.0
Soft starter	1.5

Table 1: Motor Starting Factor

Motor Rating (kW)	Starting power factor
$\leq$ 37	0.40
75	0.30
375	0.20
750	0.15

Table 2: Typical Motor Starting Power Factor

7.4. Load Flow Voltage Drop and Power Factor Studies

The following minimum parameters are required for load flow, voltage drop and power factor calculations:

- Total demand load in kW/kVA/kVAr on each branch and on each busbar for each transformer and generator;
- Demand load current flowing through each incomer and feeder branch;
- Voltage drop (%) across each individual branch and accumulated total voltage drop (%) from source of power supply to each busbar or distribution board chassis or each drive power terminal box;
- Total calculated power factor on each busbar.

The normal operating scenario of the plant as per the maximum demand calculation must be modelled for the site as well as any other scenario as determined by the Engineer. The operating load flow diagrams and summary tables must be produced indicating all the above listed parameters for the power network.

The motor starting currents and power factor assumptions are to be based upon data as defined in Table 1 and Table 2. In general, only motors up to 11kW at STP and up to 6kW at other sites may be started direct online, however, the Engineer must reference the relevant Unitywater specification when carrying out the study.

For switchboards with numerous small sized motors on the same bus the motors may be combined into suitably sized load groups when loading details are unavailable. However, if the loading details are available then SKM PTW model should reflect the site accurately. A motor of each rating must be individually modelled for the worst-case scenario to determine voltage drop at motor terminals and assume the longest length of motor cable.

The following criteria form the Load Flow Study and Maximum Demand deliverables which needs to be assessed as a part of this study:

- Bus voltage drop, load flow currents and percentage of loading based on ampere ratings.
- Protective device's percentage of loading based on ampere rating.
- Transformer and generator's percentage of loading based on ampere rating.
- Pass/fail assessment of voltage drop, and percentage loading for main switchboard, protective device, transformer, and generator against the specific criteria nominated by Unitywater.
- Output single line diagram for load flow and maximum demand study. An example of output information that needs to be shown for load flow and maximum demand study has been given in Appendix G.

The current carrying capacity and voltage drop evaluation should be performed using the following criteria.

Parameters	Evaluation Criteria	Outcome
Current Flow as a Percentage of Current Carrying Capacity	<90%	**Pass**
Current Flow as a Percentage of Current Carrying Capacity	>90% and <100%	**Marginal**
Current Flow as a Percentage of Current Carrying Capacity	>100%	**Fail**
Total Voltage Drop	≤5% or 7%[1]	**Pass**
Voltage Drop at Main Switchboard	>5% or 7%	**Fail**

Table 3: Current Carrying Capacity and Voltage Drop Evaluation Checks

For any new sites, a "Marginal" or "Fail" result will not be accepted. For existing sites, "Marginal" and "Fail" results must have further review and may require additional actions.

7.5. Power Cable Sizing

LV power cable calculations may be undertaken using PowerCAD or SKM PTW (with an Australian cables library). One calculation sheet for all consumers mains, sub mains (i.e. supplies to MSB, MCC, DB, LPD, etc) as shown in Table 4 and also at least one calculation sheet for the 'worst case' sizing of each size of motors and other ancillary load power cables. All of these calculations must be incorporated into an appendix of the PSA report. The calculations must comply with AS/NZS 3008.1.1 and AS/NZS 3000. PowerCAD or simple hand calculations may be used for parameters that are not able to be calculated in SKM PTW.

LV power cable sizing for any new plant must be incorporated into a detailed power cable schedule. The Unitywater Cable Schedule Template in Excel Spreadsheet may be used.

The power cable sizing must also be verified in an AS/NZS 3000 Cable Compliance Summary Table in the PSA report that must clearly show each cable's demand load, protective device setting and continuous current carrying capacity details as per below example:

[1] The voltage drop limit is 5% as per clause 3.6.2 of AS/NZS 3000:2018 and is acceptable to -7% as per exemption 3 of the clause.

Cable ID	Operating Scenarios	Protective Device	I_b (A)	I_n (A)	I_z (A)	Outcome	
						CCC Compliance Check	Short Circuit Compliance Check
Input component name e.g. ServiceCable	Scenario 1						
Input component name e.g. ServiceCable	Scenario 2						

Table 4: Typical Cable Compliance Check Table

LV power cable sizing must be determined considering the following criteria:

- Current carrying capacity;
- Voltage drop shall taken into consideration in accordance with the requirements of AS/NZS 3000 and AS/NZS 3008.1.1.
- Good engineering practice which may require case by case consideration to alternative voltage drop parameters depending on duty, installation features, site conditions etc.;
- Circuit breaker or fuse capacity;
- System symmetrical short-circuits rating at point of installation;
- Cable installation arrangement (derating); and
- Specific installation limitations such as underground, cable ladder, conduit etc.

The following criteria form the power cable sizing requirements:

- Current carrying capacity compliance;
- Short circuit compliance;
- Earth fault loop impedance compliance;
- Touch voltage compliance. However, it is only mandatory to check for touch voltage compliance when earth fault loop impedance is noncompliant;
- Pass/fail assessment of current carrying capacity, short circuit withstand capacity, earth fault loop impedance and touch voltage against the specific criteria nominated by Unitywater.

All the cables are evaluated against the evaluation criteria listed in Table 5.

Parameters	Evaluation Criteria	Outcome
Current Carrying Capacity Compliance	$I_b \le I_n \le 0.9 \times I_z$ (HRC Fuse) $I_b \le I_n \le I_z$ (CB)	**Pass**
Short Circuit Compliance	Permissible Short Circuit Currents > Calculated Max Short Circuit Current Or Protective Device characteristic curve below the intermediate overload and short circuit damage curves	**Pass**
Earth Fault Loop Impedance Compliance	$I_f > I_a$ Or $U_o/Z_s > I_a$	**Pass**
Touch Voltage Compliance	Tripping Time < Required Fault Clearing Time	**Pass**

Table 5: Cable Compliance Check Criteria

The PTW model for Maximum Demand, Load Flow Voltage Drop and Power Factor Studies should be configured as per Table 6 before running the study. Select the check boxes next to the study mentioned in the table.

Load Flow Study Case Options	Parameters
System Modelling - Include Utility Impedance - Include Swing Generator Impedance	 Check Check
Swing Generator Impedance - Sub-transient (R + X_d")	 Check
Solution Method - Exact (Iterative)	 Check (Max. Iteration:50)
Utility and Impedance Tolerance - Utility Voltage Tolerance - Utility Contribution Tolerance - Cable Impedance Tolerance - Transformer Impedance Tolerance	 Regular Regular Regular Regular
Newton Method Voltage Mismatch	$1*10^{-5}$ Per Unit
Include Cable Resistance Adjustment - All Cables - Specified in Individual Cable	 Check Check
Load Specification - 1st Level Demand or Energy Audit Load	 Check
Report Criteria - Bus Voltage Drop >: - Branch Voltage Drop>:	 2%[2] 3%

Table 6: Load Flow Study Case Options

[2] The voltage drop limit is 5% as per clause 3.6.2 of AS/NZS 3000:2018 and is acceptable to -7% as per exemption 3 of the clause.

7.6. Fault Study

Power network fault currents must be calculated in compliance with AS/NZS3851 and IEC60909. If transformer data or Supply Authority data is not available, the Engineer may base X/R ratios on AS 3851 and typical data from AS 2374.5 or the Supply Authority provided standard values.

A Short Circuit Fault Current Study for minimum and maximum three phase and single phase faults must be calculated at each switchboard bus and electrical distribution in the power network.

Short circuit fault current diagrams and summary tables must be produced indicating the minimum and maximum fault currents for the power network. The minimum fault levels must be used to determine the settings for protective devices.

The scenarios and operating conditions to assess the minimum and maximum fault current levels in the power network must be clearly identified in the report. A generator scenario must be included for permanent generators. Non-permanent generators will not be modelled in the studies.

A compliance check of all protective devices and switchboards against maximum prospective fault current must also be provided in a summary table in the PSA report. The purpose is to analyse if the enclosure can withstand prospective fault currents.

The following criteria form the fault level study requirements which needs to be assessed as a part of this study:

- I_k" initial symmetrical short circuit current (rms)
- I_p Peak short circuit current
- Pass/fail assessment of the main switchboard and protective device for maximum I_k" and I_p short circuit currents against the specific criteria nominated by Unitywater.
- Output Single Line Diagram of maximum and minimum fault level study. An example of output information that needs to be shown for fault level study has been given in Appendix H.

The calculated short circuit levels, the bus, circuit breakers, and/or switching device's short circuit rating will be compared to the calculated short circuit current and any issues will be highlighted with a recommendation to correct. The fault level evaluation should be performed using the following criteria.

Parameters	Switchboard Evaluation Criteria	Protective Device Evaluation Criteria	Outcome
Maximum short circuit	I_k" < 90%*I_{cw} I_p <90%*I_{pk}	I_k" < 90%*I_{cs} I_p <90%*I_{cm}	**Pass**
Maximum short circuit	90%*I_{cw} < I_k" < I_{cw} 90%*I_{pk} <I_p < I_{pk}	90%*I_{cs} < I_k" < I_{cs} 90%*I_{cm} <I_p < I_{cm}	**Marginal**
Maximum short circuit	I_k" > I_{cw} I_p > I_{pk}	I_k" > I_{cs} I_p > I_{cm}	**Fail**

Table 7: Bus and Protective Device's Short Circuit Rating Evaluation Checks

The PTW model for Maximum and Minimum Short Circuit Studies should be configured using IEC 60909 following the Table 8 before running the study. Select the check boxes next to the study mentioned in the table.

IEC 60909 Short Circuit Study Case Options	Parameters
Report and Study Options - Standard Report, No Calculation Details	Check
Short Circuit Type - Balanced & Unbalanced I_{sc}	Check
Faulted Bus - All	Check
Time Varying Report - Tk for calc I_{th}	60 cycles
Generator Impedance - Sub-transient (Rg + X_d")	Check
Voltage Factors - Specified Voltages(V) • 230 • 400 - Voltage Ranges (V) • 0 – 1000 • 1000 – 35000 • 35000 – 230000 • 230000 - 765000	Check Cmin:0.94, Cmax:1.06 Cmin:0.94, Cmax:1.06 Cmin:0.94, Cmax:1.06 Cmin:1, Cmax:1.1 Cmin:1, Cmax:1.1 Cmin:1, Cmax:1.1
Synchronous Machine Ik Calculation - Use Equation (78), or (84) meshed	Check
- Use Sequence Network to Calc Ip & I_{dc} Factors	Check
Pre-Fault Voltage - Use Voltage Factor (c)	Check
Calculate max./min. Short Circuit Currents:	I min/I max
Cable Resistance Adjustment for I_{min} - All Cables	Check (Temperature: 40 °C)
T_{min} for Ib and Idc Calcs:	0.02 (sec.)
Meshed Network X/R Adj. Method for I_p	B
Smallest impedance in group source:	0.0001 (pu)
Model Transformer Factors	Check
Transformer Tap	Check
Model Wye-Grounded Filters	Check

Table 8: Fault Level Study Case Options (IEC 60909)

7.7. Protection Coordination and Discrimination

Discrimination by time and/or current should be provided between upstream and downstream devices. Changes to existing protection settings and installed equipment should be designed and incorporated as much as is practicable to achieve coordination where anomalies are identified. Time-current curves (TCC) must be modelled and co-ordinated in the chosen software package.

Settings for each protective device must be specific to the model of circuit breaker and/or trip unit installed. User selectable settings must be clearly identified in the report. Settings which are not user configurable or factory defaults must also be identified in the report.

Appropriate settings must be calculated for each protective device and the characteristics of all protective devices on the circuit under consideration must be co-ordinated to ensure discrimination. For existing protective devices, the as-installed time-current curves and settings must be included in the report. Where modifications are required or recommended, the time-current curves of the recommended settings must be provided in a separate section within the report to demonstrate adequate discrimination. Any recommendation of settings change must go through a change process which involves a higher-level review/risk assessments and approval process. The purpose of change process is to ensure that changes are recognized, documented, formally reviewed, and approved by qualified personnel prior to their implementation in order to avoid potential safety or operational problems and to comply with appropriate regulations. The as built version of the report must be issued once setting changes have been set and tested.

Intelligent Electronic Devices (IED) are to be used where a complex protection scheme is required. IED protection functions must be clearly defined within the protection scheme.

Settings files and/or settings data sheets are to be provided for each IED. This must include all user selectable settings and settings which are not user configurable, or factory defaults must also be identified in the report. It is expected this will be provided as a printout from the IED software.

A protective device setting schedule must be prepared that indicates the settings selected for each device using the device specific nomenclature. The Power Supply Authority incomer protective device TCC must be included in the report as well as the protective device for the actual generator where the generator is fixed. The protection coordination report must include generating sets circuit breaker settings. If changes are being recommended to the existing settings then these changes must be supported by calculations.

Note: The TCC graphs must use site equipment tag numbers for protective devices and equipment where assigned. The equipment and cable numbers must match SLDs and cable schedules and other site specific documentation.

The following criteria form the protection coordination requirements which needs to be assessed as a part of the study:

- Pass/fail assessment of all switchboards against overloading condition.
- Pass/fail assessment of all switchboards against maximum and minimum short circuit currents.
- Pass/fail assessment of coordination between protective devices.
- Protection curves for all protective devices indicating the time and current discrimination between upstream and downstream protection devices for overcurrent and short circuit currents. An example of TCC curve has been provided in Appendix J.

The protection coordination study should be performed based on the following criteria.

Evaluated Parameters	Evaluation Criteria	Evaluation Outcome
All Switchboards Protected from Overload	Upstream protection devices to trip when it's loaded in excess of the rated current of the respective bus, switchboard, MCC or DB.	**Pass**
Incoming Protective Device trips for min and max faults in INST region	Upstream protection devices to trip instantaneously during the maximum and minimum short circuit condition	**Pass**
Coordination of Protective devices	Discrimination shall be provided between protective devices up to the level of an arcing fault current.	**Pass**

Table 9: Protection Coordination Evaluation

7.8. Harmonics Analysis

A harmonic analysis must be undertaken to determine the level of harmonic currents and voltage present at the site. The total harmonic distortion at the point of common coupling (PCC) on the power network must meet the requirements of the Power Supply Authority.

The magnitude of the harmonics and the total harmonic distortion must be calculated for all main bus bars.

The ratings of transformers and Generating Sets must be checked against the calculated network harmonic content.

The Engineer must prepare a harmonic design section as part of the PSA report to document the harmonic analysis. The harmonic design section must include calculated harmonic levels and spectrums for the plant at the PCC with and without harmonic reduction equipment and must make appropriate recommendations to comply with the requirements.

Vendor supplied harmonic analysis software or SKM Power Tools Harmonic Study HiWave Module containing vendor VSDs library may be used to carry out the harmonic analysis and plot the harmonic spectrums and tables.

8. Arc Flash Analysis

8.1. General

Software packages as listed in Section 7.2 must be used to determine incident energy for each switchboard.

For any existing sites where a power system augmentation occurs, if a PSA study has already been completed, Unitywater will provide the model and library for use and update.

For new sites or sites without a model, the PSA study including AFA must be completed as per this document and the detailed scope of works.

The Arc Flash Evaluation section of the PSA report must demonstrate that the calculated incident energies and corresponding Arc Flash Category for each individual SCA are within acceptable limits to Unitywater. This methodology shall begin from the Main Switchboard down to the power distribution boards at the facility.

Unitywater's preference is for incident energy on all switchboards to be less than 1.1 Cal/cm^2 which translates to Category 0 PPE as per Section 8.2.

However, if for any technical reasons this minimum level is not achievable, then the maximum incident energy level on the load side of the main incoming isolation/protection device and downstream devices is 7.5 Cal/cm^2 which translates to Category 2 PPE as per Section 8.2. This will only be considered if enough supporting evidence is provided in the PSA report or other design documentation as to the reason why the minimum level cannot be achieved.

Incident Energy above 7.5 Cal/cm^2 will not be accepted on the load side of incoming breakers by Unitywater.

The load side of all feeder breakers must have incident energy less than 1.1 Cal/cm2 or Category 0 PPE.

See Section 8.2 for further details on correlation of incident energy levels and PPE categories.

8.2. Incident Energy Levels and PPE Requirements

Unitywater has chosen the following Incident Energy levels and PPE for nominated tasks based on IEEE1584 and NFPA 70E. NFPA 70E 2018 allows the self selection of PPE categories and requirements, however Unitywater has generally followed previous guidelines with some minor modifications as per below.

Incident Energy Range	PPE Requirements	Unitywater defined PPE Category
<1.1 Cal/cm^2	• Untreated natural Fibre long sleeve with weight >4.5 Oz/SD Yd • Safety Helmet as required • Safety Glasses or Safety goggles • Workwear gloves • Safety Boots	Category 0
>1.1 Cal/cm^2 but <7.5 Cal/cm^2	• Arc flash suit/coveralls with minimum arc rating of 10 Cal/cm • Arc flash rated balaclava • Arc flash rated safety Helmet and chin strap • Safety Glasses or Safety goggles • Arc flash rated face shield • Rubber insulated workwear gloves with leather protectors • Safety Boots • (NOTE: Elements of the above may be combined i.e. a suitable helmet that includes face shield, balaclava and adequate all-round protection may be used instead of individually listed items)	Category 2
>7.5 Cal/cm^2 but <35 Cal/cm^2	• Arc flash suit/coveralls with minimum arc rating of 40 Cal/cm^2 • Arc flash rated balaclava • Arc flash rated safety Helmet and chin strap • Safety Glasses or Safety goggles • Arc flash rated face shield • Rubber insulated workwear gloves with leather protectors • Safety Boots • (NOTE: Elements of the above may be combined i.e. a suitable helmet that includes face shield, balaclava and adequate all-round protection may be used instead of individually listed items)	Category 4
>35Cal/cm^2		Category D – not allowed to work on without full isolation

Table 10: Incident Energy and PPE Requirements

8.3. Arc Flash Analysis Assumptions

For uniformity of all AFAs across all Unitywater sites, the following baseline assumptions must be made to carry out the AFA studies. These assumptions must be documented in the relevant section of the report. The engineer may choose to include additional assumptions:

- The assumptions must not conflict with those outlined in the Fault Study, Load Flow and Protection Co-ordination sections of the PSA Report. Any fine tuning in protective devices settings to reduce the arc flash category must be carried over to the Protection Coordination Section and TCCs must be updated accordingly;
- The AFA calculation is based on the latest revision of IEEE 1584 for arcing fault and the latest revision of NFPA 70E for the PPE requirements;
- The AFA must be carried out using metric units to show incident energy in Cal/cm^2 and Arc Flash Boundary in mm;
- The worker is stationary for the first two (2) seconds of an arc flash incident (constant working distance), and is directly exposed to the arc flash source during this period. It is assumed that the worker would vacate the arc flash zone after a maximum reaction time of two (2) seconds;
- To comply with the relevant Australian Standards all interrupting devices are rated for the prospective short circuit fault current (no equipment damage is considered);
- For any LV switchboard where there is adequate segregation, insulation and separation between the line side and load side cables/busbars then the calculated incident energy at the load side of the main protective device (before the busbars) shall be used to determine the arc flash category for the entire switchboard with the exception of the incoming cable compartment;
- For any LV switchboard where there is inadequate segregation, insulation and separation between the line side and load side cables/busbars then the calculated incident energy at the line side of the main protective device shall be used to determine the arc flash category for the entire switchboard;
- Form 3 and Form 4 switchboards as per AS/NZS 61439.2 (or previously AS/NZS 3439) may be considered as adequate segregation whereas Form 1 and Form 2 boards would not be considered adequate segregation;
- Arc fault contained switchboards are only contained when the switchboard doors are closed;
- The operating time of the circuit breakers modelled must be the settings shown on the TCC which are in Protection Co-ordination section. Any fine tuning must be carried to TCCs to ensure protection coordination;
- The arc flash incident is assumed to be cleared by the protective device in accordance with IEEE 1584;
- The arc flash analysis is prepared by a RPEQ Engineer and if modifications or additions to the power network are made then the power system analysis must be revised;
- Other assumptions and limitations must state explicitly what is excluded otherwise it is assumed included.

8.4. Arc Flash Assessment and Evaluation of Output Results

The following must be included as part of the AFA assessment and evaluation:

- Summarise the minimum and maximum 3-phase and 1-phase HV (where applicable) and LV fault levels from the fault calculations at the main LV switchboard incomers to the site. Briefly describe the operating or switching scenarios for the basis of these minimum and maximum fault level calculations;
- Power Supply Authority Consumer Mains LV or HV protective device ratings as installed or proposed at the site must be considered in all power system analysis

Describe the typical operating scenario along with any other scenarios that give the highest incident energy.

After running the AFA, the calculation results of the model for the entire site must be shown in the arc flash result table in the report. An example of the calculation table is shown in Appendix E. An output single line diagram is required for each scenario as a part of arc flash analysis deliverable. An example of output information that needs to be shown for arc flash study has been given in Appendix I.

Based on the arc flash study's output results given in the Appendix E table, the arc flash category and PPE requirements for all SCAs must be summarised in a Summary Table which is given in the PSA Template Report.

The SKM PTW model for arc flash study should be configured using the Table 11 before running the study. Select the check boxes next to the study mentioned in the table.

Arc Flash Analysis – Study Case Options		Parameters
Standard and Unit	Standard - IEEE 1584 2018 (Latest) NFPA 70E 2021 Annex D.4 (CSA Z462)	Check
	AC Short Circuit Method - IEC 60909	Check
	Capacitor Safe Discharge Voltage Standard - NFPA 70E	Check
	Equipment <=240 V: - Report Calculated Values from Equations	Check
	Units - Metric	Check
	Incident Energy - cal/cm^2	Check
	Distance and Boundary - mm	Check
Fault Current	Max Arcing Duration - Use Global Max Arcing Time • > 240 Volts: 2.000 (sec.) • <= 240 Volts: 2.000 (sec.)	Check
	Reduce Generator and Synchronous Motor Fault Contribution To - % Synch Generator Rated Current - % Synch Motor Rated Current - Apply To Generators - Recalculate Trip Time Using Reduced Current	300.0 300.0 Check Check
	Reduce After - Cycles	5.0
	Induction Motor Fault Contribution - Include for: - Exclude if <	5 Cycles Check (50 hp or 37 kW)

Arc Flash Analysis – Study Case Options		Parameters
	Treat Fuses As - All Standard - Current limiting starts at 0.01 sec	 Check Check
Report Options	Report Option - Worst Case Only - Bus + Line Side + Load Side	 Check Check
	Color One-Line - Bus	 Check
	Upstream Mis-Coordination Options - Check Upstream devices for mis-coordination - Upstream Levels to Search: - Mis-Coordination ratio:	 Check 3 80%
	Line Side + Load Side Fault Contribution Options - Line + Load Sides	 Check
	- Cleared Fault Threshold: - Default Label # Prefix:	80 % of Total #
	Device to Report in Labels and Summary View - Last Trip Device	 Check
	Report Options when Equipment Evaluation Failed - Report IE/PPE - Show Equip Eval Notes and Failed as Worst Case	 Check Check
	Device Fail to Operate, Use Upstream Devices - None	 Check
	- Report PPE Level - Report PPE Others - Report Function Name for multiple functions - Append bus description to bus name - For VCBB, also run VCB, report Worst IE/FB - For HCB, also run VCB+VCBB, report Worst IE/FB	Check Check Check Check Check Check

Table 11: Arc Flash Evaluation Study Case Options

8.5. Conclusion and Recommendations

The operating scenarios causing the highest incident energy in each switchboard or enclosure in the power network shall be shown. This section must define the categories of PPE required for each switchboard.

8.6. Arc Flash Labels

This section contains details of the arc flash labels required for each switchboard, distribution board and all other electrical enclosures containing LV power sources.

The arc flash labels are in addition to other mandatory labelling required by Australian Standards.

The following types of arc flash labels are the standard format prepared by Unitywater. CAD file of these labels can be provided or alternatively Brady Workstation Custom Designer Lite software templates can be provided for use on Brady BBP31 or Brady 3100 label machine.

The following arc flash labels must be used across Unitywater sites:

- Label Type 1
- Label Type 2
- Label Type 3
- Label Type 4
- Label Type 5

All label types except Label Type 1 are to be made from a high quality sun resistant adhesive vinyl. It is recommended that the following labels are used with the Brady printers listed above.

For Label Type 2 and Label Type 3: Brady B-595 Vinyl Film with Permanent Adhesive (https://www.bradyid.com/labels/aggressive-adhesive/b30-series-pre-printed-pre-cut-vinyl-blank-sign-headers-cps-brus-10056?part-number=b30-25-595-oshada)

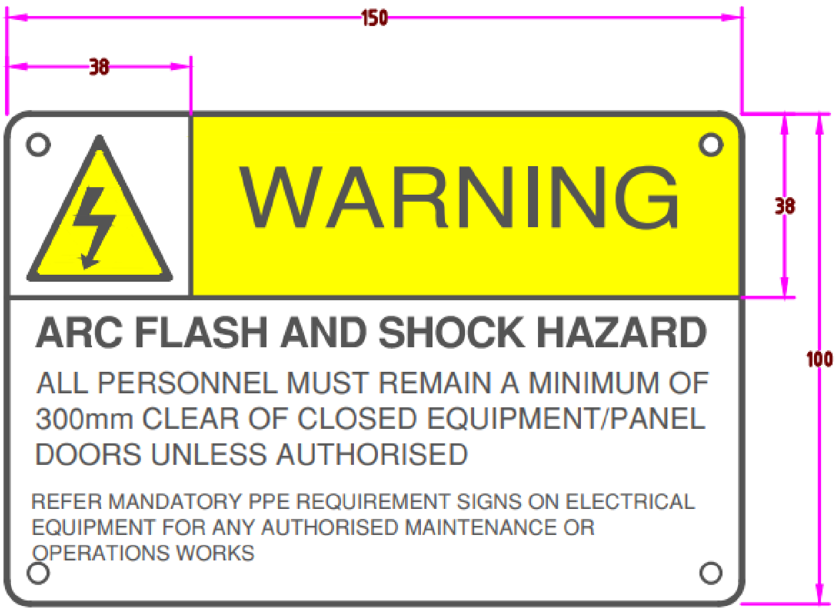
For Label Type 4: B30 Series Continuous Indoor Outdoor Vinyl Labels – Yellow (https://www.bradyid.com/labels/aggressive-adhesive/b30-series-continuous-indoor-outdoor-vinyl-labels-cps-brus-10054?part-number=B30C-2250-595-YL)

For Label Type 5: B30 Series Continuous Indoor Outdoor Vinyl Labels - White

(https://www.bradyid.com/labels/aggressive-adhesive/b30-series-continuous-indoor-outdoor-vinyl-labels-cps-brus-10054?part-number=B30C-2250-595-WT)

7.6.1 Label Type 1

This label type is a metallic label required to be installed on access doors of LV switchrooms only. It is not required on pump stations' outdoor type switchboards which are exposed to community.



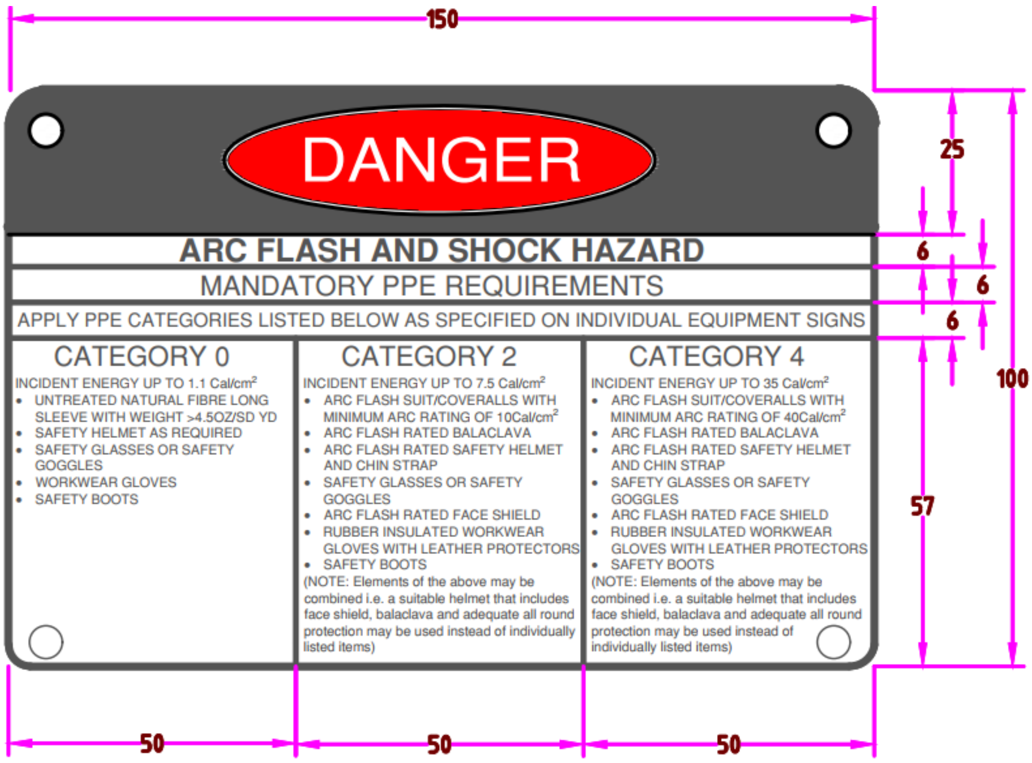
ARC FLASH AND SHOCK HAZARD SIGN - TYPE 1

TO BE INSTALLED ON SWITCHROOM ENTRANCE DOORS OR SITE ENTRANCE GATES AND NETWORK PUMP STATIONS WITHIN A BUILDING

7.6.2 Label Type 2

This label type is required to be installed on every LV switchboard, distribution board or electrical enclosure.

For LV switchboards in public access, this must be installed behind the common control cubicle's front door.



ARC FLASH AND SHOCK HAZARD SIGN - TYPE 2 PPE REQUIREMENTS

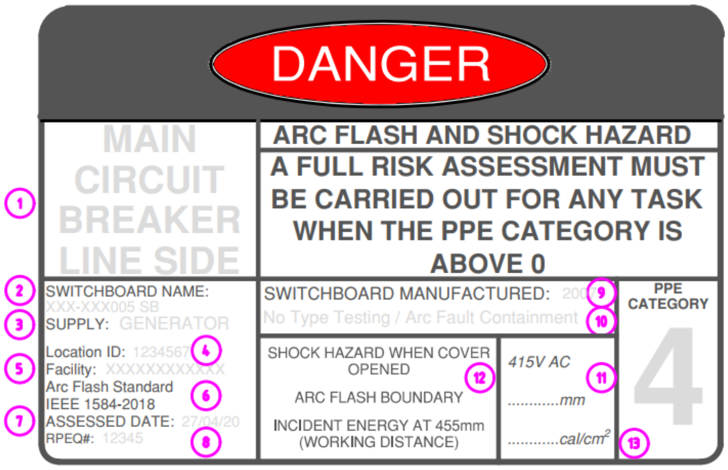
7.6.3 Label Type 3

This label type is required at every LV switchboard, distribution board or electrical enclosure. These will contain specific arc flash information related to each switchboard except where the switchboard meets criteria for Label Type 4.

Label Type 3 has been designed to clearly show the following information on the switchboards:

1. Details of the specific location of the arc flash hazard
2. Switchboard Name;
3. Point of supply (i.e. Mains supply or Generator supply);
4. Maximo Location ID of the switchboard;
5. Maximo facility where the switchboard is located;
6. The standard to which the incident energy calculation is based on.;
7. Assessment Date;
8. The RPEQ engineer who carried out the study;
9. The year the switchboard was manufactured;
10. Whether the switchboard is type tested to a particular standard with or without arc fault containment;
11. Arc flash boundary rounded up to the nearest 500mm;
12. Incident energy bands in Cal/cm²
    a. <1.1Cal/cm2
    b. <7.5Cal/cm2
    c. <35Cal/cm2
    d. >35Cal/cm2
13. Category of PPE required at the working distance.

Further information around standard terms and guidance on the use of this label can be found in Appendix C.

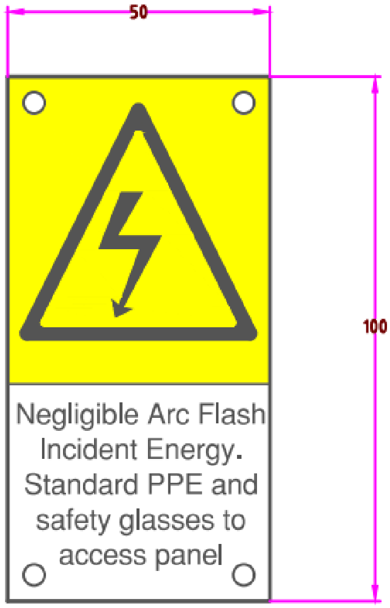


ARC FLASH AND SHOCK HAZARD SIGN - TYPE 3
CIRCUIT BREAKER OR ISOLATOR FOR LINE SIDE OR LOAD SIDE

7.6.4 Label Type 4

This label type is required to be installed at the following LV components where they are fed from an upstream MCB and the PPE category has been confirmed by AFA to be Category 0. Examples of these include:

- Single phase LV switchboards;
- Single phase Distribution boards;
- Control panels; and
- UPS units and distribution.

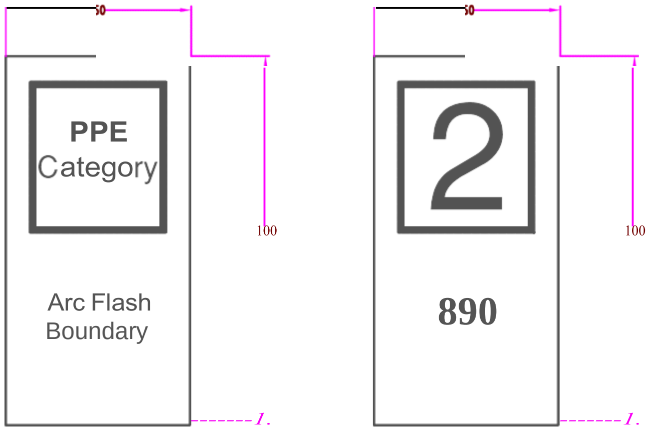


ARC FLASH AND SHOCK HAZARD SIGN - TYPE 4
LOW RISK SITES

7.6.5 Label Type 5

This label type is required to be installed on switchboards that require multiple doors (i.e. outer door and escutcheon) to be opened to access equipment. It is only to be installed on switchboards where the PPE category is greater than 0. The label is to show the PPE category (2, 4 or D) and the arc flash boundary in mm.

It is expected that this label will generally only be required in network switchboards, however there may be a need to use this label type in STP switchboards in some circumstances.



ARC FLASH AND SHOCK HAZARD SIGN - TYPE 5

7.6.6 Label Placement

Labels are to be placed in appropriate locations on the switchboard. A label placement guide is shown in Appendix K. This should be referenced in the first instant for appropriate locations for labels, however if further clarification is required, then it must be reviewed by Unitywater Electrical Engineering personnel prior to installation.

9. Appendices

Refer to the following pages.

Appendix A - Definitions/Abbreviations

Definitions

The following definitions are used throughout this specification and within the Power Systems Analysis Report Templates. The report templates are to use these definitions.

Term	Meaning
Arc Flash Boundary	The distance from an arcing fault within which unprotected skin could receive a 2nd degree burn. Generally considered the distance from an exposed arc source where the incident energy equals 1.2 Cal/cm^2.
Arc Flash Incident Energy	The amount of thermal energy on a surface (or person is exposed to) at a specific distance (typically called a working distance) from an arc flash. Measured in Cal/cm^2
Bus Arcing Fault Current	The current flowing to a bus fault when the three phases are in contact through an arc. The arcing fault current is calculated from the Bolted Fault Current value using empirical formulae developed by the IEEE.
Bus Bolted Fault Current	The current flowing into a bus fault when the three phases are in contact and the impedance between them is zero.
Capacity	In the load flow single line diagrams presented in the report, “Capacity” has been expressed as a percentage of the load current on the Current Carrying Capacity. A Capacity greater than 100% indicates that the Cable or Transformer is overloaded.
Cascading	Cascading is the use of the current limiting capacity of circuit breakers or fuses at a given point to permit installation of lower-rated circuit breakers downstream.
Coordinated	Two protection devices are said to be coordinated if the upstream device has a longer operating time than the downstream device for all values of current. Or in other words, the time-current characteristic curve of the upstream device is higher and to the right of the time-current characteristic curve of the downstream device for all values of current. If two characteristic curves intersect or the upstream device time-current characteristic curve is below the downstream device time-current characteristic curve the devices are not coordinated.
Complex Site	A Sewage Treatment Plant or a Plant that has multiple large 3 phase switchboards
Current Carrying Capacity	The current rating of Cables or Transformers taking into account installation methods and ambient temperature variations.
Discrimination Time	The difference in the operating times between two protective devices
Diversity Factor	The ratio of running loads over the maximum demand load over a period of time.
Engineer	Person carrying out the PSA and AFA Studies.
Gap Between Busbars or Conductors	The spacing between busbars or conductors at the arc location.
Generating Sets	A device for converting one form of energy into electrical energy to provide power to a Plant – generally a diesel generator but can include solar PV arrays and Cogen engines.
Overhead Earth Wire (OHEW)	A protective earth wire strung above the active conductors of a transmission line, designed to protect the line from direct lightning strikes.
Opening Time	The time required for a circuit breaker to open after receiving a trip signal from a relay.
Pickup Current	The current at which a protection device (or protection element of a protection device with multiple stages, for example, an overload stage and an instantaneous stage) changes from an un-energised state to an energised state. After picking up, the protection device (or protection element) will operate based on its time-current characteristic curve. If the current drops below the pickup current before the protection device (or protection element) operates it will, in effect, return to an un-energised state based on its reset characteristics.

Term	Meaning
Pickup time	Required time for a protective device to issue a trip signal based on the TCC curve.
Plant	A Unitywater site that contains Unitywater switchboard assets.
Point of Common Coupling (PCC)	The Power Supply Authority power supply point of connection to the Plant. NOTE: Sometimes also called Point of Attachment (POA), however PCC is to be used.
Power Supply Authority	Legal Entity responsible for providing electrical power to customers.
Power Systems Analysis and Arc Flash Assessment Report	A report detailing relevant power system analysis and arc flash assessment includes Maximum Demand, Power Cable Sizing and Compliance, Fault Current Details, Protection Coordination and Discrimination, Arc Flash Requirements.
Power System Site Data Collection Template (F11199)	A document that may be used to collect relevant power system data for input into the PSA Model.
PPE Category	Indicates the Personal Protective Equipment (PPE) required to prevent an incurable burn at the working distance from an exposed arc source during an arcing fault.
Prospective Short Circuit (Fault) Current	The current that would flow if the short circuit was replaced by an ideal connection of negligible impedance without any change of the supply.
Protective Device Arcing Fault Current	The current flowing through a protective device under arcing fault conditions.
Protective Device Bolted Fault Current	The current flowing through a protective device under bolted fault conditions.
Rated Short Circuit Making Capacity (Icm)	The highest instantaneous value of current that the circuit-breaker can establish at rated voltage in specified conditions.
Rated Service Short Circuit Interrupting Capacity (I_{cs})	The rated breaking capacity (I_{cu}) or (I_{cn}) is the maximum fault-current a circuit-breaker can successfully interrupt without being damaged.
Rated Short-Time Withstand Current (I_{cw})	The r.m.s. value of the alternating current component which a circuit breaker is able to withstand without damage for a predetermined time, preferred values being 1s and 3s.
Rated Ultimate Short Circuit Breaking Capacity (I_{cu})	The maximum breaking capacity of a circuit breaker at an associated rated operational voltage and under specified conditions.
Simple Site	A Plant that has only one switchboard – generally a Unitywater network site i.e. Sewage Pump Station, Water Pump Station, Reservoir. Simple sites may also include several small sub boards (i.e. distribution boards, control panels etc.). An example of this may be a site that has a Main Switchboard which then feeds a switchboard for pumps, and then a further power Distribution Board.
Short Circuit (Fault)	The accidental or intentional connection, by a relatively low resistance or impedance, of two or more points in a circuit that are normally at different voltages.
Short Circuit (Fault) Current	The current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit.
Trip Time	The time required for the protective device to operate for the given fault condition. In the case of a relay, the breaker opening time is entered separately from the relay trip time. For low voltage breakers and fuses, the trip time is assumed to be the total clearing curve or high tolerance of the published trip curve.
Unitywater Electrical Engineering Personnel	Unitywater's nominated team who are the stakeholders of PSA projects.
Working Distance	The distance between the arc source and the worker's body. The arc flash incident energy is calculated at the specified Working Distance. The working distance is generally 455mm.

Table 12: Key Definitions

Abbreviations

The following abbreviations are used throughout this specification and within the Power Systems Analysis Report Template. The report templates are to use these abbreviations.

Term	Meaning
AC or ac	Alternating current
AFA	Arc Flash Analysis
CB	Circuit Breaker
CCC	Continuous Current Carrying
DB	Distribution Board
DOL	Direct On-line Starter
FLC	Full Load Current
HCB	Horizontal Electrodes inside a metal "box"
HOA	Horizontal Electrodes in Open Air
HV	High Voltage
I_a	The current at Disconnection Time of 5.0 Sec Based on the Protection Device
I_b	Maximum Demand
I_{cm}	Making Capacity of the protective device at rated voltage
I_{cs}	Service Breaking Capacity of the protective device at rated voltage
I_{cw}	The rated short-time withstand current of the main switchboard
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
I_f	Minimum Single Line to Ground Initial Symmetrical Short Circuit Current (RMS)
I_k (3Ph)	Three Phase Steady-State Short Circuit Currents (RMS)
I_k (SLG)	Single Line to Ground Steady-State Short Circuit Currents (RMS)
I_k (LL)	Line to Line Steady-State Short Circuit Currents (RMS)
I_k (LLG)	Double Line to Ground Steady-State Short Circuit Currents (RMS)
I_k" (3Ph)	Three Phase Initial Symmetrical Short Circuit Current (RMS)
I_k" (SLG)	Single Line to Ground Initial Symmetrical Short Circuit Current (RMS)
I_k" (LL)	Line to Line Initial Symmetrical Short Circuit Current (RMS)
I_k" (LLG)	Double Line to Ground Initial Symmetrical Short Circuit Current (RMS)
I_n	Nominal Current of the Protective Device
I_p (3Ph)	Three Phase Peak Short Circuit Current (Instantaneous)
I_p (SLG)	Single Line to Ground Peak Short Circuit Current (Instantaneous)
I_p (LL)	Line to Line Peak Short Circuit Current (Instantaneous)
I_p (LLG)	Double Line to Ground Peak Short Circuit Current (Instantaneous)
I_{pk}	The rated peak withstand current of the main switchboard
I_z	Continuous Current Carrying Capacity of the equipment
LRC	Locked Rotor Current
LV	Low Voltage (as defined in AS/NZS 3000)
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MCC	Motor Control Centre

Term	Meaning
PCC	Point of Common Coupling
PPE	Personal Protective Equipment
PSA	Power System Analysis
PVC	Polyvinyl Chloride
R_g	Resistance of a Synchronous Machine
RPEQ	Registered Professional Engineer of Queensland
RMU	Ring Main Unit
SCA	Switchgear & Controlgear Assembly
SKM PTW	SKM Power Tools for Windows
SLD	Single line Diagram
TCC	Time Current Curve
T_{min}	The minimum time delay, as set in the fault level study
U_o	The nominal A.C (RMS) Voltage to Earth (230 V)
VCB	Vertical Electrodes inside a metal “box” enclosure
VCBB	Vertical Electrodes Terminated in a “barrier”, inside a metal “box”
VOA	Vertical Electrodes in Open Air
VSD	Variable Speed Drive
X_d”	Sub-transient Reactance of a Synchronous Machine (effective reactance at the moment of short-circuit).
X_d’	Transient Reactance of a Synchronous Machine (effective reactance at the moment of short-circuit).
XLPE	Cross-Linked Polyethylene
Z_s	The impedance of the earth fault-loop impedance comprising the source, the active conductor up to the point of the fault, and the return conductor between the point of the fault and the source.

Table 13: Key Abbreviations

Appendix B - References

General

All studies are to be carried out to relevant Australian Standards, where no Australian Standard exists, work must conform to the most applicable, current IEC Standard and any specific international standard as referenced in this specification.

Where conflict exists between different Codes, Standards or Regulations, the higher requirement must apply.

The following legislation, related Regulation and Codes apply to this specification:

- *Electricity Act 1994* (Qld);
- *Electrical Safety Act 2002* (Qld);
- *Electrical Safety Regulation 2013* (Qld);
- *Electricity Regulation 2006* (Qld);
- *Work Health and Safety Act 2011* (Qld); and
- *Work Health and Safety Regulation 2011* (Qld).

International and Australian Standards

All power system analysis and arc flash analysis studies must comply with the current edition of the following standards:

Standard	Title
AS ISO 1000	The international system of units (SI) and its application
AS/NZS 60076.5:2012	Power Transformers Part 5 – Ability to Withstand Short-Circuit
AS/NZS 3000:2018	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008.1.1:2017	Electrical installations – Selection of cables for alternating voltages up to 0.6/1kV – Typical Australian installation conditions
AS/NZS 3010:2017	Electrical installations – Generating sets
AS 3851:1991 (R2015)	The Calculation of short-circuit currents in three-phase a.c. systems
AS/NZS 5000.1:2005	Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 (1.2) kV
AS/NZS 61000.3.4:2007	Electromagnetic Compatibility (EMC) Part 3.4 Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 75A.
AS/NZS 61000.3.6:2012	Electromagnetic Compatibility (EMC) Part 3.6 Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1992, MOD)
AS/NZS 61439.1:2016	Low-voltage switchgear and controlgear assemblies - General rules (IEC 61439-1)
AS/NZS IEC 60947 series	Low-voltage switchgear and controlgear
IEC 60255 series	Measuring Relays and Protection Equipment
IEC 60909	Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents
IEEE 1584:2018	IEEE Guide for Performing Arc Flash Hazard Calculations
IEEE 519:2022	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
NFPA 70E:2018	Standard for Electrical Safety in the Workplace

Table 14: Key Standards

Relevant documents that relate to this specification

The following list is provided for information only.

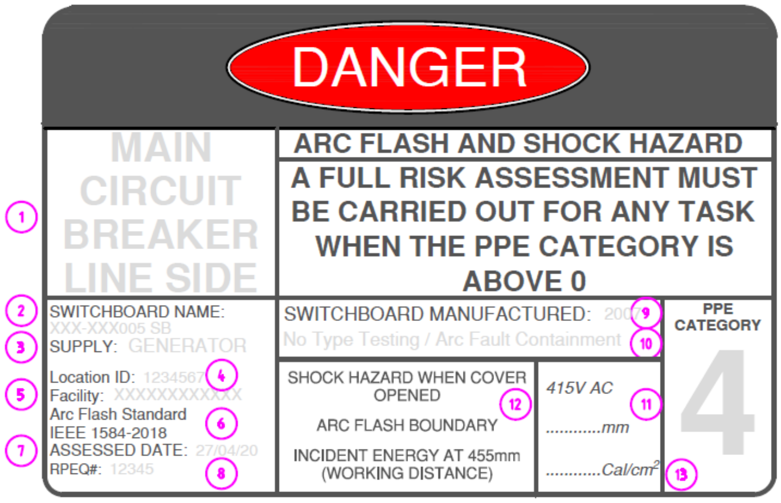
Document Number	Title
Manual 0295 (previously known as BMS1607)	Energex Supply and Planning Manual (dated 17/01/2019)
STD00978 (previously known as BMS03329)	Energex Pole Transformer Fusing Standard (Version 3, released 11/09/2014)
4920-A4	Energex Overhead Construction Manual Section 2 – Services (Issue 33.1 dated 11/08/2022)
Manual 00305	Energex Underground Distribution Construction Manual – Section E1 – Assemblies (Version 26 dated 01/07/2021)
Manual 00305	Energex Underground Distribution Construction Manual – Section E4 –Cable Installation & Testing (Version 26 dated 01/07/2021)
Manual 00305	Energex Underground Distribution Construction Manual – Section E5 – LV Joints and Terminations (Version 26 dated 01/07/2021)
Pr8843	Unitywater Specification for Drawing, Document and Equipment Tag Numbering
Pr9380	Unitywater Specification for Electrical Installations at Network Sites
Pr9835	Unitywater Specification for Electrical Installation at Treatment Plants
Pr9913	Unitywater Specification for Acoustic Enclosed Generators at Unitywater Sites (Supply and Installation)
Pr9914	Unitywater Specification for Solar Power Supply and Installation at Unitywater Sites
F10884	Report Template - Power System Analysis - Network Sites
F10886	Report Template - Arc Flash Analysis - Single Phase Sites
F11199	Power System Site Data Collection Template
Pr11079	Power Systems Analysis Change Management Procedure
Pr10973	Working Around Switchboards Guide
1OARFA	Related training: 1OARFA - Arc Flash Awareness Course (UW)
	UNITY WATER ARC FLASH LABELS - TYPES 12345 - 14-07-2023 (A7693154) - .dwg label file
	UNITY WATER ARC FLASH LABELS - TYPES 12345 - 14-07-2023 (A7693158) - .pdf label file

Table 15: Energex and Unitywater Manual

Appendix C - Guideline for Type 3 Label

The following labels can be found in Objective in both .dwg and .pdf file formats.

UNITY WATER ARC FLASH LABELS - TYPES 12345 - 14-07-2023 (A7693154) and *UNITY WATER ARC FLASH LABELS - TYPES 12345 - 14-07-2023 (A7693158)*



ARC FLASH AND SHOCK HAZARD SIGN – TYPE 3 CIRCUIT BREAKER OR ISOLATOR FOR LINE SIDE OR LOAD SIDE

The following is provided to standardise and guide the preparation of this label type.

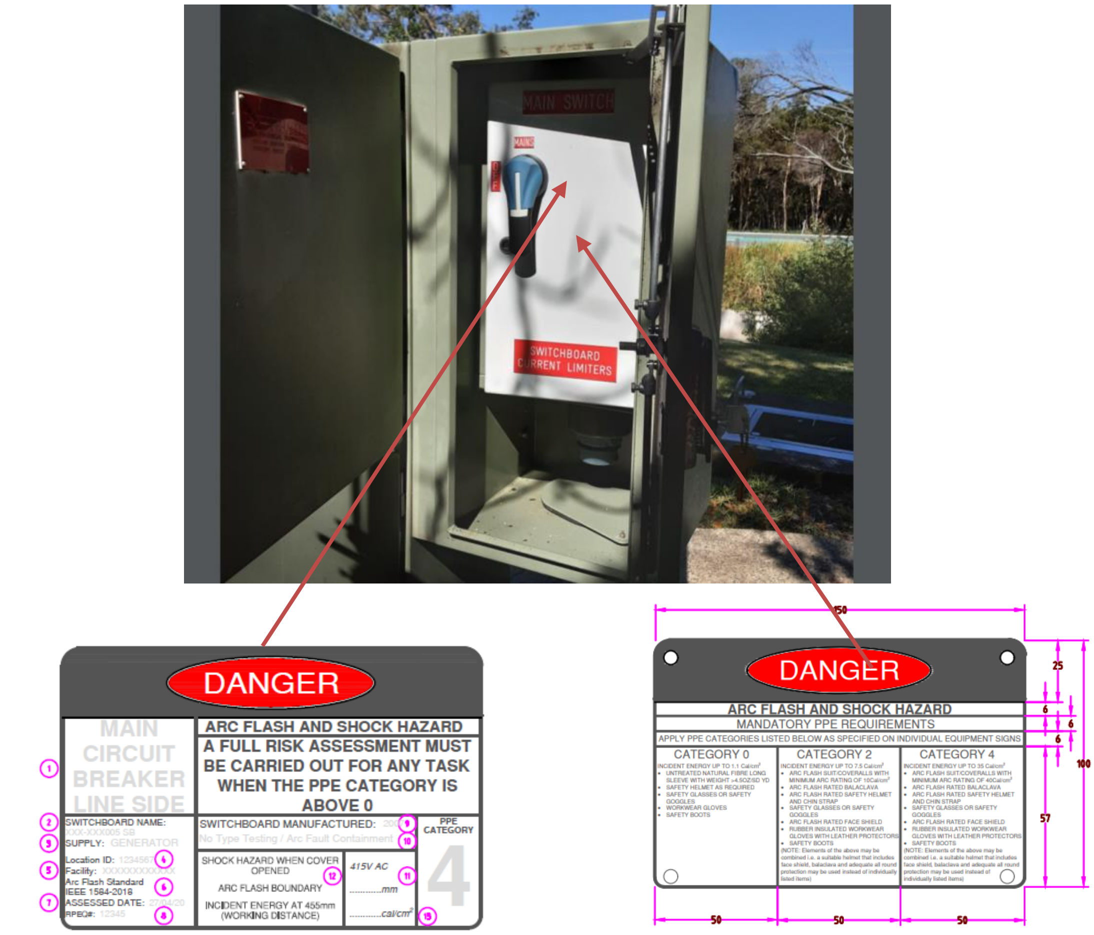
Item Number	Description	Text Options	Full Example for this field
1	Details of the specific location of the arc flash hazard	Selectable Text **Main Isolator OR Main Circuit Breaker** AND **Line Side OR Load Side**	MAIN CIRCUIT BREAKER LINE SIDE
2	Switchboard Name – insert the switchboard name as per drawings	Permanent Text – **SWITCHBOARD NAME:** Additional Text – Free text & numbers	 MCC9101
3	Source of supply associated with this label	Permanent Text - **SUPPLY:** Selectable Text **MAINS OR GENERATOR**	SUPPLY: MAINS
4	The specific Location ID where the switchboard is Located	Permanent Text - **Location ID:** 7 digit numerical field NNNNNNN	
5	The Facility	Permanent Text - **Facility:** Network OR STP	 Network: AAA-AAANNN STP: Refer Pr8843
6	Applicable standard the arc flash assessment and this label has been prepared using. Unitywater will advise of applicable standard	Permanent text – **Arc Flash Standard: IEEE1584-2018**	Arc Flash Standard: IEEE1584-2018
7	Date the arc flash assessment was conducted	Permanent Text – **Assessed Date:** Additional text – date of report	Assessed Date: 27/4/2019
8	RPEQ number of engineer who carried out study (not their name)	Permanent Text – **RPEQ#:** Additional text – Specific registered number of RPEQ engineer	RPEQ#: 123456
9	Year the switchboard was manufactured	Permanent Text – **Switchboard Manufactured:** Additional Text – year switchboard was manufactured	Switchboard Manufactured: 2017
10	Details of type testing and arc fault containment for the switchboard.	Selectable Text - Only these options for text may be used: **No Type Testing/Arc Fault Containment** OR **Type Tested to older Standard (AS3439)** OR **Type Tested to AS61439 with no Arc Fault Containment Tests** OR **Type Tested to AS61439 with Arc Fault Containment Tests** OR **Type Tested to AS3439 with Arc Fault Containment Tests** OR **Type Tested to IEC61439 with Arc Fault Containment Tested to AS61439 Appendix ZD** OR **Type Tested to IEC61439 with no Arc Fault Containment Tests**	No Type Testing/Arc Fault Containment
11	Incident Energy at working distance of 455mm	Selectable Text - Only these options for text may be used: **<1.1Cal/cm²** OR **<7.5Cal/cm²** OR **<35Cal/cm²** OR **>35Cal/cm²**	<1.1Cal/cm²
12	Arc Flash Boundary in mm	Permanent text - **mm** Additional Text – Free text – a number rounded up to nearest 500mm	1000mm
13	PPE requirements based on the incident energy at the working distance of 455mm	Permanent Text – **PPE Category** Selectable Text – **0** OR **2** OR **4** OR **D**	PPE Category 2

For LV switchboards in public access, this must be installed behind the common control cubicle's front door adjacent to the Type 2 Label. For all other switchboards it will be installed near the associated main circuit breaker/isolator.

This label must be installed on the line side of the associated main circuit breaker/isolator. Where the incident energy on the load side differs to the extent that the PPE category changes then a second label must be installed which indicates the incident energy and PPE category for the load side.

Where permanent generators are installed on site additional labels must be installed which indicate the source of supply (Mains or Generator) and the relevant results as shown on the label. These additional labels may also be required in other sections of the board and must be installed where Cat2 PPE or above is required when running off generator supply.

An example of label placement is shown in the figures below and a full guide is shown in Appendix K.



ARC FLASH AND SHOCK HAZARD SIGN – TYPE 3
CIRCUIT BREAKER OR ISOLATOR FOR LINE SIDE OR LOAD SIDE

ARC FLASH AND SHOCK HAZARD SIGN – TYPE 2
PPE REQUIREMENTS


MAIN SWITCH
MAINS
OFF
DANGER
ARC FLASH AND SHOCK HAZARD
MAIN ISOLATOR LINE SIDE
A FULL RISK ASSESSMENT MUST BE CARRIED OUT FOR ANY TASK WHEN THE PPE CATEGORY IS ABOVE 0
0
DANGER
ARC FLASH AND SHOCK HAZARD
MANDATORY PPE REQUIREMENTS


DANGER
0

Appendix D - Guideline for Validation Checks of PTW PSA Model

The following is included as a reference only when SKM Power Tools for Windows is used as the modelling software package.

Unitywater or others will undertake a review of PTW model and libraries as outlined in this section. It is the Engineer's obligation to ensure that the checks are completed to at least the minimum standard nominated in this section. Any departures or concerns must be brought to Unitywater's attention. It is the Engineer's obligation to rectify any anomalies, errors or inaccuracies etc that maybe identified by Unitywater or others at any time during project execution and after Contract practical completion.

1. Data Integrity – General Checks:

a. Check PTW options and general settings – look under project options for things like Standards (IEC), units (metric), Wiring (mm^2), Frequency (50Hz), etc.

b. Check paths for reference library and miscellaneous files (will point to your previous project opened in PTW, and needs to be directed to the particular project instead).

c. Check incoming supply / Utility / Energex POS details – has max and min FL's been modelled properly reflecting actual conditions for the site, e.g. 3-Ph, L-G, X/R ratio's, voltage levels, etc?

d. Check if alternate source of supply is model (e.g. Generator), it's also modelled correctly with machine specific data (e.g. Sub transient, transient impedances, ratings, etc.). Check also that generator not set as a swing bus (if operating in parallel with utility) – instead, set to PQ operating mode.

e. Check the project's referenced data libraries (obtained from the project back-up) – are there any new elements created by the consultant for the relays, protective devices, elements (cable, load, motor), etc? – If yes, then the checks are more exhaustive as the level of new component modelling will depend entirely on the diligence of the consultant in defining the relay models, settings parameters, etc.

f. Check site SLD and compare against the number of circuits as modelled in the project one-line … is there a good match? If not, then likely not all loads have been modelled, and/or lumped loads used.

g. Produce a cable schedule from the project file, and compare the cable lengths against the site cable schedule (if one exists) – if not, review the project cable lengths - are they all conveniently the same lengths or just rounded up to nearest 10 or 50 metres? (will affect accuracy of voltage drop and earth fault loop impedance calculations, especially for borderline circuits).

h. Check cable ampacity of the cables modelled – has consultant modelled the method of installation, deratings, etc? – should be evident in the ampacity values.

i. Check for 'hidden' buses or 'hidden elements' (an impedance is required between any two buses, but not necessarily shown on one-line).

j. Also check for buses by 'expanding them' to reveal if there are any elements still in-service but not visible (yet affecting the PSA results). Use PTW's search and go-to functions, or run custom Query's.

k. Check all protective devices are modelled in each circuit – HV relays, LV ACB's, EF relays, etc.

l. For EF relays, check that the 'Function' of that relay is set to Sensor type being "neutral" instead of "phase", otherwise that relay will be used in the AF calculations and will show a faster clearing time for the same arcing current (and hence a lower Incident Energy Level, which is inaccurate).

m. Check each protective element – ensure that under 'Function' that the correct O/C element is ticked for 'Used in Arc Flash' calculations, otherwise it will be bypassed altogether irrespective of whether that element is properly graded with and lower in the TCC than the upstream protection element.

n. O/C LV Protection elements that are not selected in Arc Flash studies are likely entered as 'Ground Fault' CB's in the library, and should instead be in the Static Trip section.

o. Check project has no lumped loads or modelling methods which could cause inaccurate PSA results – e.g. motor contribution generally ignored for motors < 37kW but if many are lumped together as one, can affect S.C and A.F values.

2. Load Flow:

a. Perform a load flow analysis – are there any fatal errors or errors reported by PTW? – Typically, bus voltage levels not set, or more than one swing bus defined, etc.

b. Check load flow results against the site's metered maximum demand – is the site demand as modelled overly excessive? – this would indicate careless modelling of the loads, and not taking into account load diversity, mode of operation (e.g. 2 x pumps, duty-standby), running load of motors (which typically only run at 60-80% of their NPR due to conservative motor sizing to be higher than the pump size), etc.

c. An excessive load model will indicate overloaded transformers, overloaded cables, etc. Check primary plant ratings and loading & incoming power supply load draw – compare against rating or connection agreement capacity.

d. In the Load Flow Study 'set-up' section, check that the 'Load Specification' is set to "1st Level Demand or Energy Audit Load" (and not "Connected Load"), otherwise, all loads will be used in the LF calculation with no diversity.

e. Set the voltage drop tolerances (e.g. 5%) and branch VD tolerance (e.g. 3%) in the LF solution criteria. This is used to flag and report on buses with low voltage levels.

f. Check voltage drop report – any buses exceeding limits?

g. Check branches – are there any ampacity issues, exceedance of cable rating, excessive branch losses?

h. For motors, check the starting PF, LRA.FLA ratio, running PF, etc. Check also the 'Diversity' and 'Load Factor' … are they all set to 1.0?

i. Also check all motors – are they modelled as "running" or "starting" in the LF? Some motors could still be left in "starting" mode – use the correct data-block to identify this.

j. Use the appropriate data-block to display the PSA results to audit the study – chose a data-block that's appropriate to what you want to see.

k. If performing Transient Motor Starting (TMS) studies, check if there are any Starters, VSD's, DOL's – are they modelled correctly? (for both motors and the connected loads to the motor's – e.g. torque-speed curves, load and motor moment of inertia, etc.). Has the consultant linked these to a custom motor and load library? If yes, check it.

3. Short Circuit:

a. Perform a Short Circuit analysis – understand the difference between “Comprehensive” and “IEC 60909” options. Comprehensive takes into account current shifts in parallel paths (e.g. two transformers supplying same downstream bus) in the TCC. Unitywater only accept comprehensive for the arc flash analysis and AS3851(IEC60909) for the fault study.

b. For IEC 60909, check for Meshed network X/R adjustment method, use “C”.

c. For “Comprehensive”, check Pre-Fault voltage settings – some will result in a more conservative SC result (e.g. PU voltage if set to 1.03 for all buses). Also, check if motor contributions are checked.

d. Under the Short Circuit study setup, check for faulted bus … is “All buses” chosen or “selected buses” only?

e. Check if the prospective FL’s from the Short Circuit study exceed any plant rating – e.g. HV CB or switchgear rating, LV MCC rating, etc.

f. Check transient models of generators and motors – is the impedance data reasonable and accurate (not just typical and generic).

g. Check motor contributions, and verify motor contribution paths. Are they reasonable? Are you getting large contributions from small motors?

h. Check study conditions that motors < 37kW (50 HP) are ignored in the study – this is in the Arc-Flash study setup dialog box.

4. Protection Coordination:

a. Visually check the protection coordination – select the PD’s you want to see, then select ‘go-to TCC drawing’ … do the TCC’s appear to all coordinate properly?

b. Show device TCC’s up to the fault rating at the bus to ensure full coordination.

c. Check the protection margins between devices – both in the ‘time domain’ as well as the ‘current domain’.

d. For current-domain margins, need to ensure there’s adequate margin to account for additional loads from other parts of plant if the upstream device carries more load.

e. When visualising the TCC for coordination, do it in small steps – first, for primary plant & incoming supply. Then add more + more downstream devices to the TCC to confirm coordination.

f. When checking coordination of parallel paths (e.g. 2 x TX’s supplying one downstream bus), ensure the TX curve is shifted by the current axis scaling to account for the current division. Also, for Ph-Ph faults on secondary side of Dyn transformer, need to shift TX curve to the left by 0.866 factor.

g. Focus on the larger loaded circuits or circuits with large motors and transformers.

h. Check against the motor starting curves, starting times, inrush factor, asymmetrical inrush, etc. For high efficiency motors, LRA/FLA ratio can be as high as 19x, instead of usual 7-8x.

i. Check transformer inrush factor and time is not overly conservative (~8x , instead of 12x FLC ; 0.1 sec). Also check the X/R ratio has been set properly.

j. For any generators modelled, check that sub-transient and transient impedance values used are “saturated” values, not “unsaturated” values from the generator data-sheets. If only one Xd” value is shown, assume it’s is un-saturated, and hence apply a factor of 0.85 to it.

5. Arc Flash:

a. Check AF study options – what standards are they referring to (i.e. NFPA 70E latest version). Check also Units (metric) and Incident Energy (cal/cm²) and distance (mm).

b. Check global max arcing time set to 2.0 secs

c. Exclude contributions from motors < 50 HP; but include motor contributions for 2.5 cycles.

d. Check also "fixed or movable" options for each bus.

e. Check if Fuses are used – that the minimum melt curve is not used, but 'total clearing time' curve instead.

f. Under Report Options, check IE and Flash Boundary definition tables used (70E 2015).

g. Do an AF study, compare arcing current against the TCC's visually – is the device which is reported by PTW as having operated for the fault 'intuitively correct'? If not, investigate further.

h. Has HV CB opening time been entered in the HV relays definition (if not, then AF results will be better than actual due to shorter clearing time in the calcs). LV CB clearing times are accounted for in the CB clearance tolerances.

i. Check the AF report / spread-sheet – are LV devices set properly (e.g. bus spacings)?

j. Check the AF report / spread-sheet – what levels are reported for the Incident Energy Levels at the faulted buses? Do any appear to not be intuitively correct? (Higher Levels / Cat's are generally higher upstream due to both higher fault current and longer clearance times, for the same bus voltage).

k. Check if device operate times are reasonable. For MCC's > 800A, AS3000 requires instantaneous setting pick up at 30% of prospective fault current to ensure fast clearance times.

l. Check protective device libraries – have any custom protective elements been created specifically for the project by the consultant? Has consultant used the correct PD / relay (and not just conveniently selected from what's only in the LIB_AS?) e.g. Terasaki vs Hawker Siddley.

m. Review the settings 'segments' in each PD created – are they 'feature rich'? – e.g. SI, VI, EI curves, Instantaneous, time delays, I^2t shoulder options, etc. have been defined?

n. For relays, do all settings appear to be "continuously" adjustable? (some relays plug or pick-up or time-multiplier settings are only available in discrete steps).

o. For new elements (e.g. cables, transformers, drives, etc.) – check if master data LIB_AS library is matched to project library. May need to import elements from the project library to the master library (once the PD data accuracy has been validated).

p. Check AF results spread-sheet for N5 errors – e.g. mal-grading, etc.

q. Also check if 85% if Arcing Current has been used in the IE levels (N3) and visually check on TCC – presents an opportunity to move the instantaneous further to the left to reduce clearing times and IE levels.

6. Harmonics:

a. Check has there been any harmonic producing loads modelled in the project? Are they modelled properly with harmonic sources from a library?

b. Check Harmonic Distortion levels – do they appear to be reasonable?

c. If Power Factor Correction is modelled, do an impedance frequency scan to see if there are any susceptible resonant frequencies to certain order harmonics.

7. Study Conditions / Scenarios:

a. Examine the no. of scenarios created – if more than 3 or 4, ask why and what for? – understand each scenario's details and conditions of the model, and reference back to the PSA report for explanation of the scenario's considered.

b. Use data-visualiser to examine differences between each scenario - changes against the 'base case' will appear to be pink (e.g. setting changes).

Appendix E - Arc Flash Results

Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Protective Device Bolted Fault (kA)	Protective Device Arcing Fault (kA)	Trip/Delay Time (sec)	Breaker Opening Time/Tol. (sec)	Equipment Type	Electrode Configuration	Enclosure Height (mm)	Enclosure Width (mm)	Enclosure Depth (mm)	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (cal/cm^2)	PPE Level / Notes

Appendix F - Input Data Single Line Diagram Information

Component	PTW Attributes	Description
Utility	ComponentName	Component Name
	SC Contribution 3P	SC Contribution 3Ph (kA)
	X/R 3P	X/R 3Ph
	SC Contribution SLG	SC Contribution SLG (kA)
	X/R SLG	X/R SLG
	SystemNominalVoltage	Voltage Level (V)
Transmission Line	ComponentName	Component Name
	Model	Description/Model
	Length	Length
	NumCircuits	Number of Circuits
	RatedVoltage	Rated Voltage
	Ampacity	Ampacity
	UDF_Comment	Configuration
Cable	ComponentName	Component Name
	CableSize	Cable Size
	Conductor Desc	No. of Cable /Phase, Conductor, and Insulation Type
	SystemNominalVoltage	Rated Voltage
	Ampacity	Ampacity
	Length	Length
	Installation	Installation Method
	UDF_Comment	No of Neutral Cable and Size
	UDF_DocNum	No of Earth Cable Cand Size
	AdditionalDerating	Derating Factor
	InsulationClass	Insulation Class
Protective Device (Fuse, Circuit Breaker, Relay)	ComponentName	Component Name
	Settings	Frame/Rating or Size
	FrameVoltage	Voltage Level (V)
	SeriesRating	Rated Breaking Capacity
	Frame/Voltage	Breaker Model
	Type	Trip Unit Model
	Manufaturer	Manufacturer
Transformer	ComponentName	Component Name
	Nominal kVA	Nominal KVA
	Pri RatedVoltage	Primary Voltage
	Sec RatedVoltage	Secondary Voltage
	Z%	Impedance
	X/R	X/R ratio
	Pri Tap	Primary Tap
	Sec Tap	Secondary Tap
	Vector Group	Vector Group

Component	PTW Attributes	Description
Bus	ComponentName	Component Name
	SystemNominalVoltage	Voltage Level (V)
	ContinuousRating	Continuous Current Rating
	ShortCircuitRating	Short Circuit Current Rating
	Description	Form of Segregation
	AF_BoxDepth	Box Depth
	AF_ BoxHeight	Box Height
	AF_BoxWidth	Box Width
	AF_ElectrodeConfig	Electrode Configuration
Induction Motor	ComponentName	Component Name
	RatedSize	Rated Size (kVA)
	FLA	Rated Amps
	RatedVoltage	Voltage Level (V)
	NumMotors	Number of Motors
	PF	Power Factor
	Efficiency	Efficiency
	Load Factor	Load Factor
Lump Load	ComponentName	Component Name
	Rated kVA	Rated Size (kVA)
	RatedAmps	Rated Amps (A)
	RatedVoltage	Rated Voltage (V)
	PF	Power Factor
	Load Factor	Load Factor
Generator	ComponentName	Component Name
	Rated kW	Rated kW
	Rated kVA	Rated kVA
	RatedKVAR	Rated KVAR
	Rated PF	Rated PF
	RatedVoltage	Rated Voltage
	RatedAmps	Rated Amps
	Xd"	Xd"

Appendix G - Load Flow Study Output Single Line Diagram Information

Component	PTW Attributes	Description
Utility	ComponentName	Component Name
	LF kVA	LF kVA
	LF kW	LF kW
	LF kVAR	LF kVAR
	LF Current	LF Current
	LF PF	LF PF
Transmission Line	ComponentName	Component Name
	LF Current	LF Current
	LF Current (%)	LF Current Loading (%)
	LF PF	LF Power Factor
	LF VD(%)	Voltage Drop (%)
	LF kW	LF kW
	LF kVAR	LF kVAR
Cable	ComponentName	Component Name
	LF Current	LF Current
	LF Current (%)	LF Current Loading (%)
	LF VD(%)	LF Voltage Drop (%)
	LF kW	LF kW To Bus
	LF kVAR	LF kVAR
	LF PF	LF Power Factor
Protective Device (Fuse, Circuit Breaker, Relay)	ComponentName	Component Name
Transformer	ComponentName	Component Name
	LF Current (%)	LF Current Loading (%)
	LF Current	LF Current Primary
	LF Current Sec	LF Current Secondary
	LF KVA	LF KVA
	LF kW	LF kW
	LF kVAR	LF kVAR
	LF PF	LF Power Factor
	LF VD%	LF Voltage Drop (%)

Component	PTW Attributes	Description
Bus	ComponentName	Component Name
	LF Current	LF Current
	LF Voltage	LF Voltage
	LF VD(%)	LF Voltage Drop (%)
	LF kW	LF kW
	LF kVAR	LF kVAR
	LF PF	LF Power Factor
Induction Motor	ComponentName	Component Name
	LF Current	LF Current
	LF Voltage (%)	LF Voltage (%)
	LF PF	LF Power Factor
	LF kW	LF kW
	LF KVAR	LF KVAR
Lump Load	ComponentName	Component Name
	LF Current	LF Current
	LF Voltage (%)	LF Voltage (%)
	LF PF	LF Power Factor
	LF kW	LF kW
	LF kVAR	LF kVAR
Generator	ComponentName	Component Name
	LF Current	LF Current
	LF Voltage (%)	LF Voltage (%)
	LF kVA	LF kVA
	LF kW	LF kW
	LF PF	LF Power Factor

Appendix H - Fault Level Study Output Single Line Diagram Information

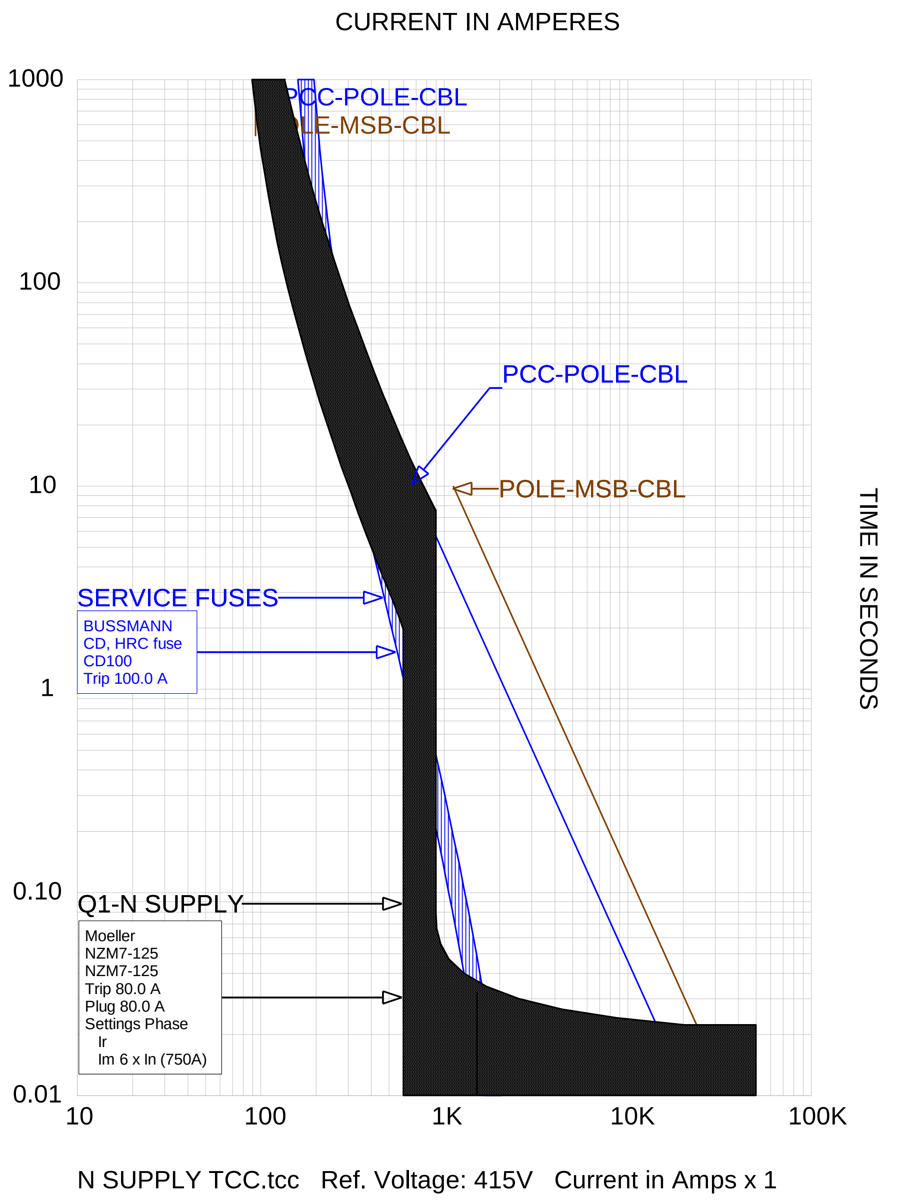
Component	PTW Attributes	Description
Utility	ComponentName	Component Name
	Rated MVA	Rated MVA
	pu Rpos (100 MVA Base)	R positive
	pu Xpos (100 MVA Base)	X positive
	pu Rzero (100 MVA Base)	R zero
	pu Xzero (100 MVA Base)	X zero
Transmission Line	ComponentName	Component Name
	IEC909 Ip 3Ph To Bus	IEC Ip 3Ph
	IEC909 Ikpp 3Ph To Bus	IEC Ik" 3Ph
	IEC909 Ik 3Ph To Bus	IEC Ik 3Ph
	IEC909 Ip SLG To Bus	IEC Ip SLG
	IEC909 Ikpp SLG To Bus	IEC Ik" SLG
	IEC909 Ik SLG To Bus	IEC Ik SLG
Cable	ComponentName	Component Name
	IEC909 Ip 3Ph To Bus	IEC Ip 3Ph
	IEC909 Ik" 3Ph To Bus	IEC Ik" 3Ph
	IEC909 Ik 3Ph To Bus	IEC Ik 3Ph
	IEC909 Ip SLG To Bus	IEC Ip SLG
	IEC909 Ik" SLG To Bus	IEC Ik" SLG
	IEC909 Ik SLG To Bus	IEC Ik SLG
Protective Device (Fuse, Circuit Breaker, Relay)	ComponentName	Component Name
	SeriesRating	Rated Breaking Capacity
Bus	ComponentName	Component Name
	IEC909 Ip 3Ph	IEC Ip 3Ph
	IEC909 Ik" 3Ph	IEC Ik" 3Ph
	IEC909 Ik 3Ph	IEC Ik 3Ph
	IEC909 Ip SLG	IEC Ip SLG
	IEC909 Ik" SLG	IEC Ik" SLG
	IEC909 Ik SLG	IEC Ik SLG

Component	PTW Attributes	Description
Induction Motor	ComponentName	Component Name
	Rated Amps	Rated Amps
	LRA/FLA	LRA/FLA
	IEC909 Ip" 3Ph	IE Ip" 3Ph
	IEC909 Ik" 3Ph	IEC Ik" 3Ph
	IEC909 Ik 3Ph	IEC Ik 3Ph
	X"d	X"d
Lump Load	ComponentName	Component Name
Generator	ComponentName	Component Name
	IEC909 Ip 3Ph	IEC Ip 3Ph
	IEC909 Ip 3Ph	IEC Ik" 3Ph
	IEC909 Ik" 3Ph	IEC Ik 3Ph
	IEC909 Ik 3Ph	IEC Ip SLG
	IEC909 Ip SLG	IEC Ik" SLG
	IEC909 Ik" SLG	IEC Ik SLG
	IEC909 Ik SLG	IEC Ip 3Ph
	X"d	X"d

Appendix I - Arc Flash Study Output Single Line Diagram Information

Component	PTW Attributes	Description
Utility	ComponentName	Component Name
Transmission Line	ComponentName	Component Name
Cable	ComponentName	Component Name
Protective Device (Fuse, Circuit Breaker, Relay)	ComponentName	Component Name
	AF_IncidentEnergy	Incident Energy
	AF_PPE Level	PPE Level
	AF_ArcingFault	Arcing Fault Current
	AF_TripTime_LineLoadSide	Trip Time
	AF_ProtDev	Protected Device
	AF_Boundary	Arc Flash Boundary
	AF_WorkingDistance	Working Distance
Bus	ComponentName	Component Name
	AF_IncidentEnergy	Incident Energy
	AF_PPE Level	PPE Level
	AF_ArcingFault	Arcing Fault Current
	AF_ArcingFault@ProtBr	Arcing Fault Current at Protective Device
	AF_ProtDev	Protected Device ID
	AF_TripTime	Trip Time
	AF_Gap	Gap
	AF_Boundary	Arc Flash Boundary
	AF_WorkingDistance	Working Distance
Induction Motor	ComponentName	Component Name
Lump Load	ComponentName	Component Name
Generator	ComponentName	Component Name

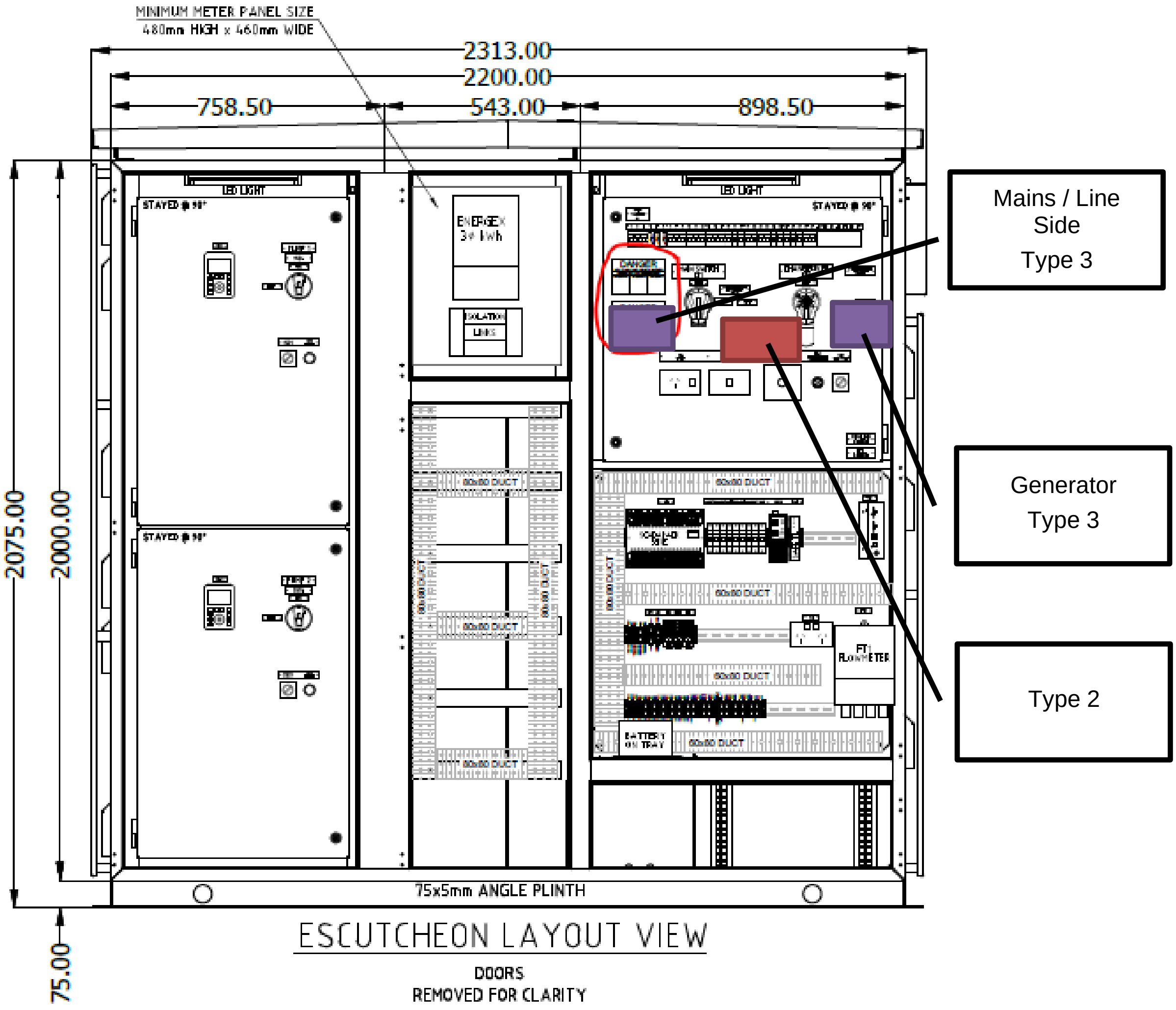
Appendix J - Example of Time Current Curve (TCC)



Appendix K - Arc Flash Label Placement Guide

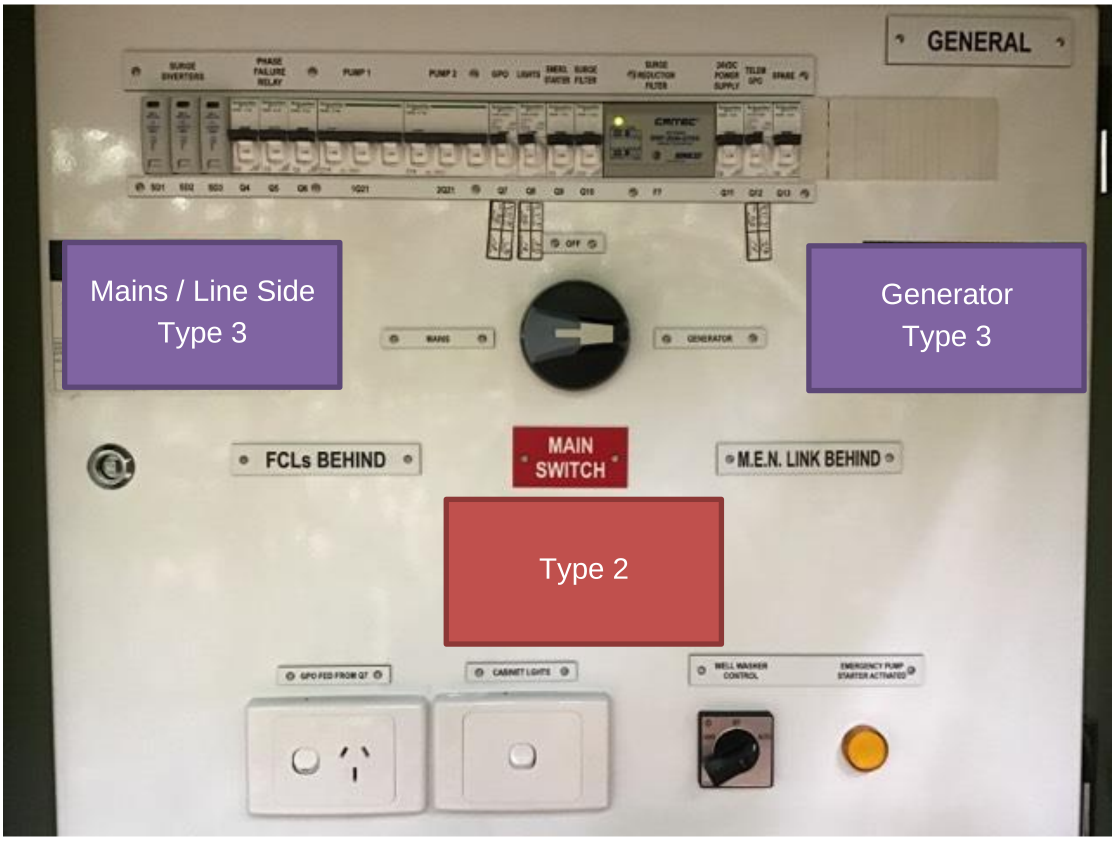
Type 1 labels:
On the door of the Building.
Type 2 labels:
In a suitable location near the line side Type 3 label.
Type 3 labels:
Needs to go above line side and below load side (if different) one label for a generator main switch and one for the Energex main switch (if different).

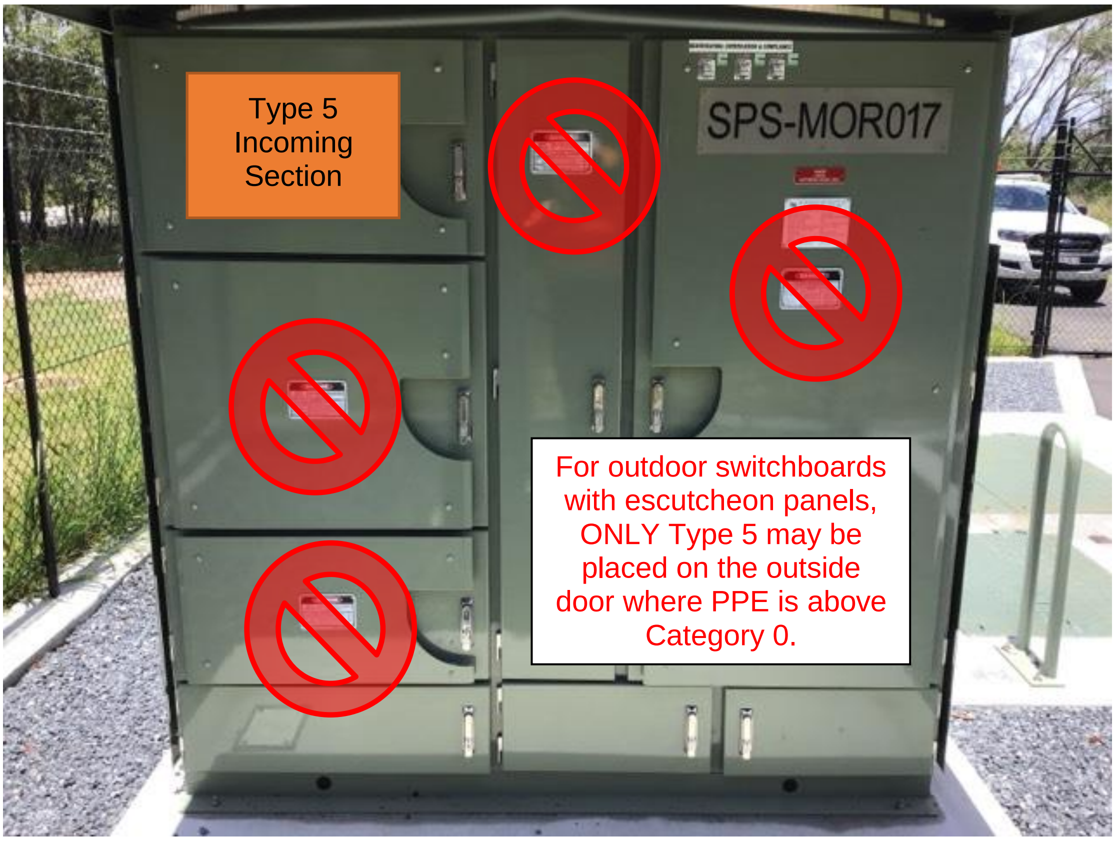
Note: Photo examples shown below clarify this instruction where possible.

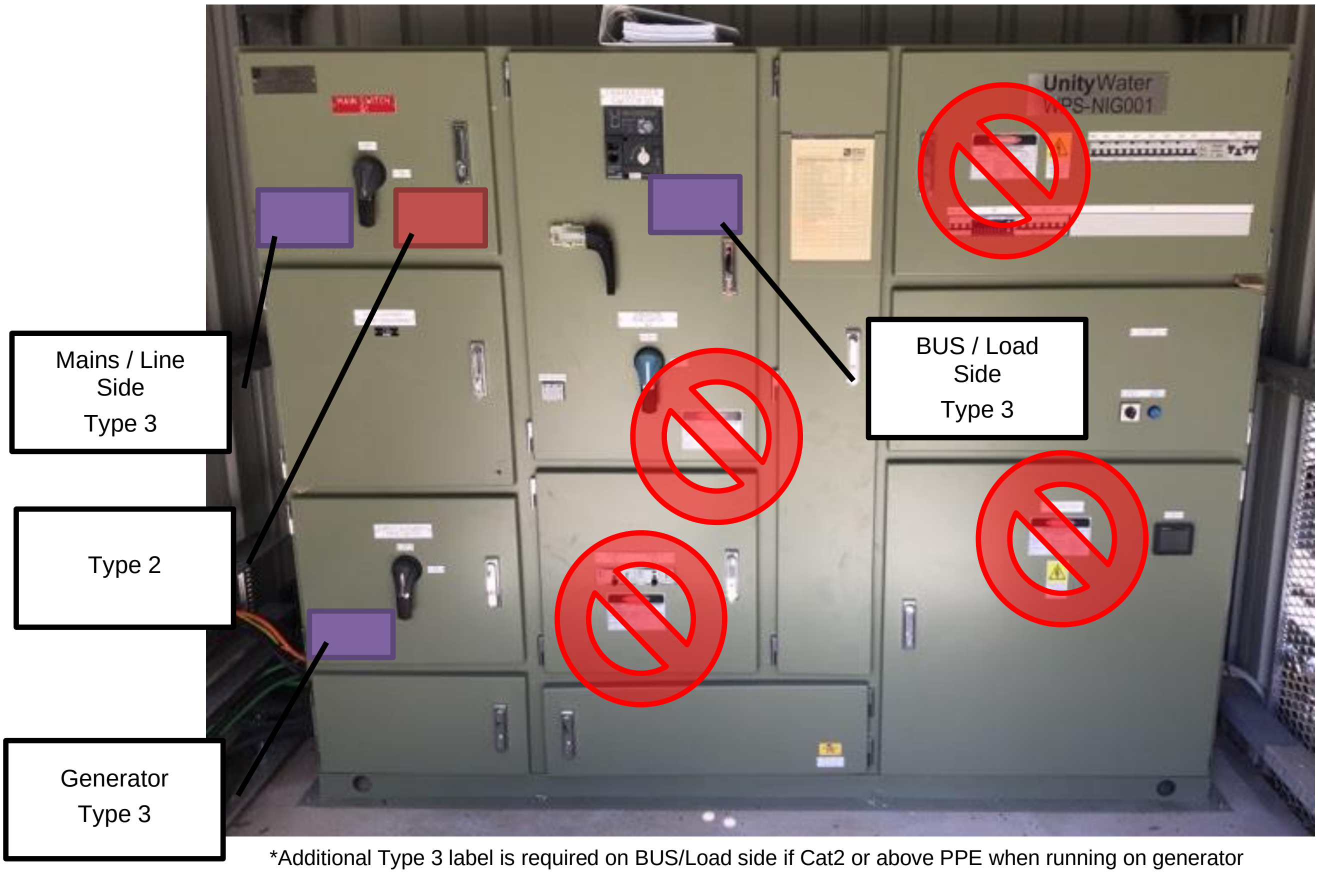


Examples

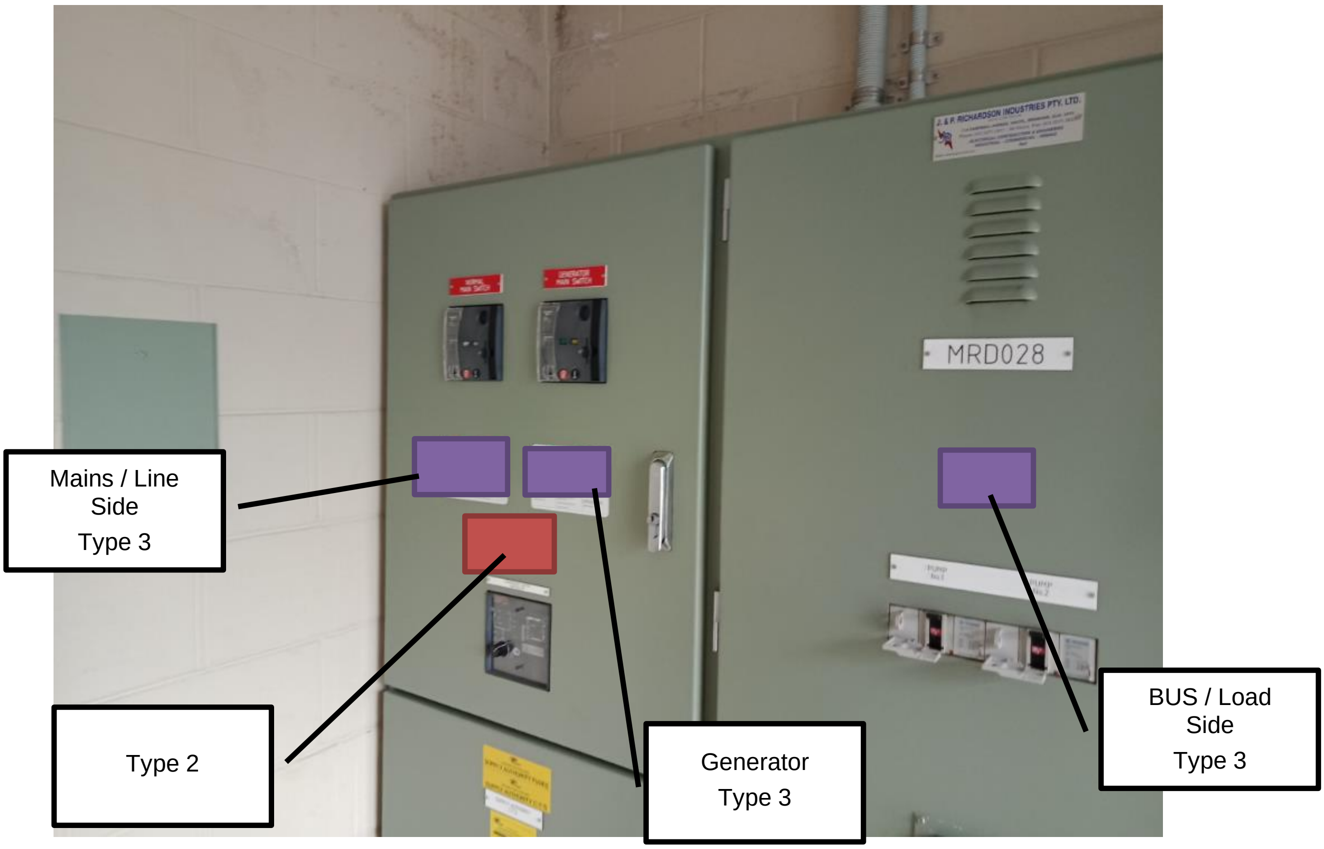
The photographs below provide an example of label placements for different switchboards and switchboard arrangements. If in doubt, please contact your Unitywater / project representative for clarification.



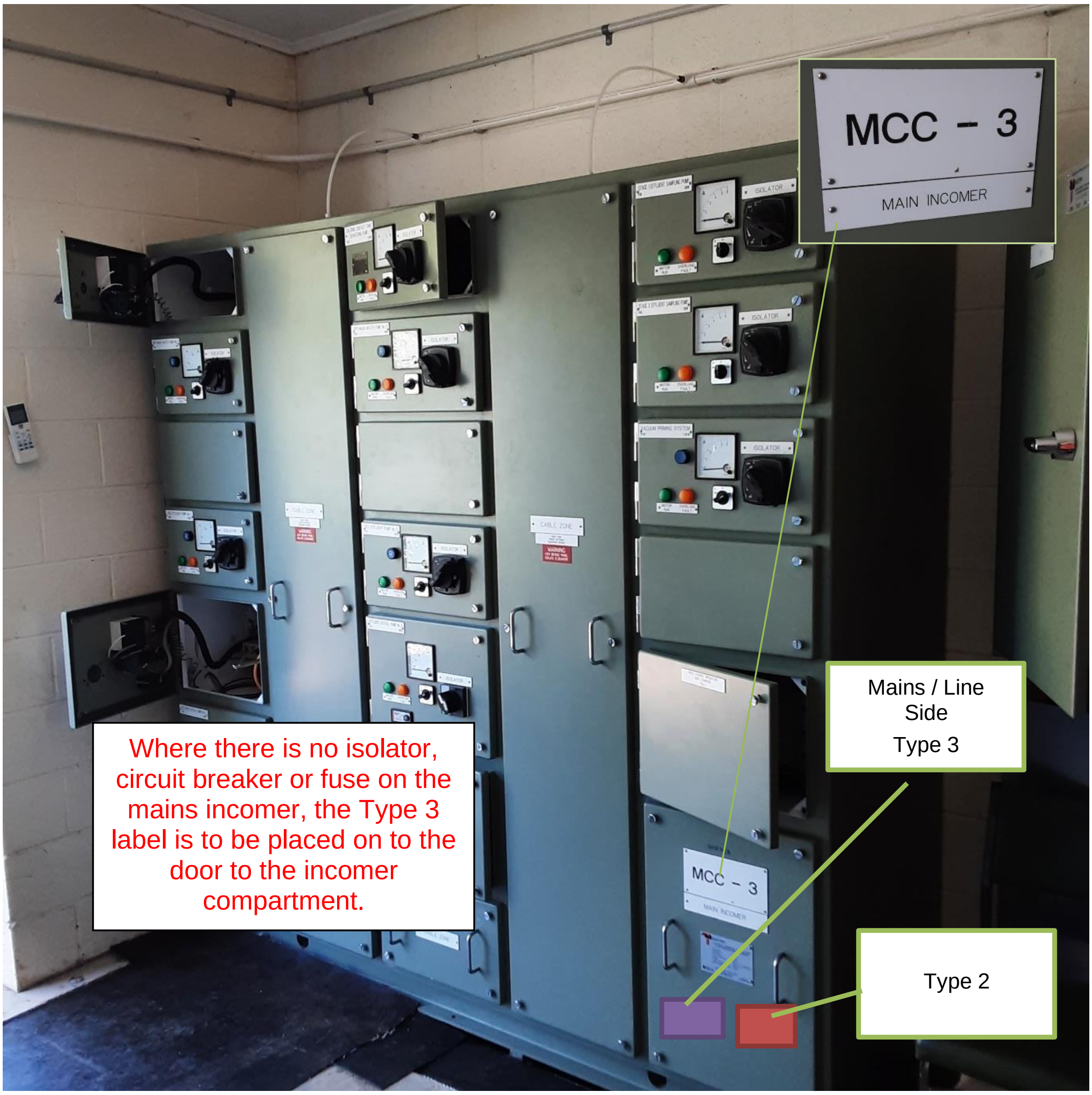

Type 5 Incoming Section
SPS-MOR017
For outdoor switchboards with escutcheon panels, ONLY Type 5 may be placed on the outside door where PPE is above Category 0.

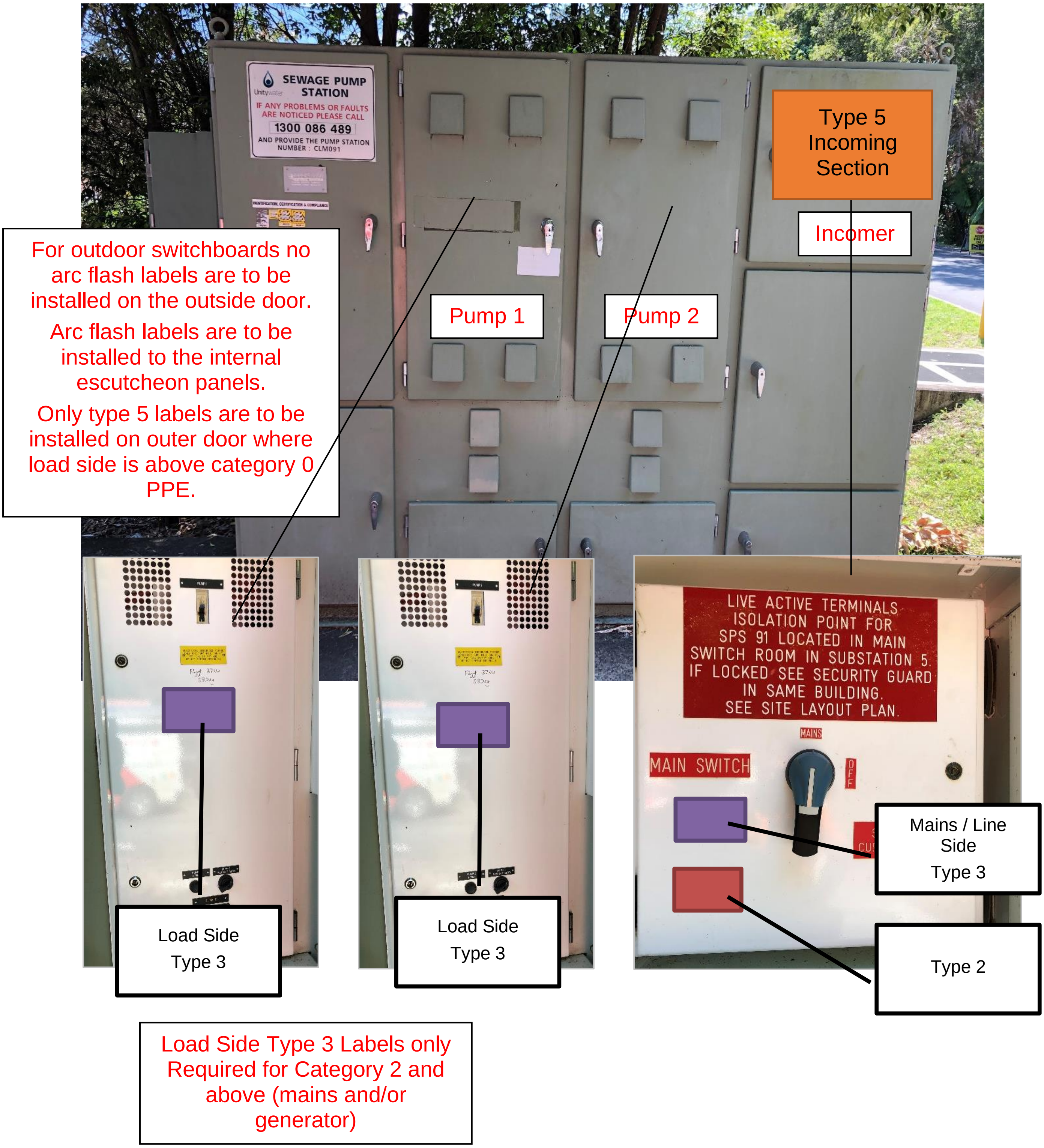


*Additional Type 3 label is required on BUS/Load side if Cat2 or above PPE when running on generator



*Additional Type 3 label is required on BUS/Load side if Cat2 or above PPE when running on generator


MCC – 3
MAIN INCOMER
Mains / Line Side
Type 3
Type 2
Where there is no isolator, circuit breaker or fuse on the mains incomer, the Type 3 label is to be placed on to the door to the incomer compartment.
MCC – 3


SEWAGE PUMP STATION
IF ANY PROBLEMS OR FAULTS ARE NOTICED PLEASE CALL
1300 086 489
AND PROVIDE THE PUMP STATION NUMBER : CLM091
Type 5 Incoming Section
Incomer
Pump 1
Pump 2
For outdoor switchboards no arc flash labels are to be installed on the outside door.
Arc flash labels are to be installed to the internal escutcheon panels.
Only type 5 labels are to be installed on outer door where load side is above category 0 PPE.
LIVE ACTIVE TERMINALS ISOLATION POINT FOR SPS 91 LOCATED IN MAIN SWITCH ROOM IN SUBSTATION 5. IF LOCKED SEE SECURITY GUARD IN SAME BUILDING. SEE SITE LAYOUT PLAN.
MAINS
MAIN SWITCH
Mains / Line Side Type 3
Type 2
Load Side Type 3
Load Side Type 3
Load Side Type 3 Labels only Required for Category 2 and above (mains and/or generator)


Type 5 Incoming Section
SEWAGE PUMP STATION
MAIN SWITCH
SWITCHBOARD CURRENT LIMITERS
CABINET
Mains / Line Side Type 3
Load Side Type 3
Load Side Type 3 Labels only Required for Category 2 and above
Type 2